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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES EQUIPMENT AND SUPPLIES ASSOCIATION.

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Industrial House-Moving.

Some considerable time ago we drew attention in these columns to the unmistakable tendency of British industry to move South. We commented on the view that had been repeatedly expressed in some quarters to the effect that such a drift implied "a permanent transference of prosperity from the old-established staple industries"—located in the North—"to the newer developments"—chiefly to be found in the South. We gave it as our view that nothing of the kind need be inferred, and that the southward drift was connected closely with the decreasing dependence of our industries on a local source of power. We further pointed out that in itself such a drift might be regarded as a hopeful sign, showing as it does a conscious effort on the part of industry to adapt itself to new conditions.

Some interesting figures bearing closely upon this problem have recently come to light. The first of these relate to the industrial population insured against unemployment, as given by the Ministry of Labour. The numbers in the South-Eastern section of England—east of a line running approximately from the Wash to Portsmouth—increased during the two years just past by 261,000, while the numbers insured north of this line had only increased by 40,000. It is stated that the Ministry of Labour considers these figures to be largely the result of transfers of workers from the distressed mining areas—the Northern section, so given, including the great bulk of these—but whatever the cause the result is the same, namely a transference of industrial activity and industrial personnel from North to South.

The other set of figures, which are most illuminating, afford a comparison of rates as between the two areas. Here we would again suggest that it is necessary to differentiate carefully between cause and effect. It is just as probable that high rates are the result of distress and poverty in a district as that they are the cause of industry seeking another milieu. The rates over the Northern industrial areas give an approximate average of 15s. in the pound, some of the higher figures being: Jarrow, 21s. 3d.; Keighley, 20s. 9d.; Sheffield, 20s. 4d.; Hartlepool, 20s. Much lower figures prevail in the South, where Acton is cited with a rate of 12s. 8d.; Salisbury, 11s. 10d.; Woking, 10s. 9d.; Oxford, 6s. 10½d. The London rates vary from 9s. 2d. in Westminster to 17s. 6d. in Bermondsey, but, if certain exceptions be made, notably Poplar, the average lies between 11s. and 12s.

The obvious interpretation, and the one that is most often put upon figures of this kind, is quite simple, that our national prosperity is shifting from North to South. This is about as gloomy a prospect for industrialists in the North as it is for an unemployed man to hear that the problem of unemployment cannot be solved in our time. There is, of course, no doubt that the South is becoming comparatively industrialised, the new industries—as we have pointed out, the electrical trades, motor manufacture, artificial silk—growing up in districts that have hitherto been largely agricultural. There is also no doubt that changes in national policy may react unfavourably on armament manufacture, and engineering developments in the use of heavy oil will affect the coal trade. But in a day when it is fashionable to bewail such figures as those we have quoted, we think it desirable to repeat what we have already said, that they are just as likely to be cause or effect. Lower rates in the South may tempt industry thither if the North does nothing about it; they do not mean that industry has already decided to move house.

Banking and Industry.

Many years ago in this column we deplored the lack of help that the banking interests accorded to industry, and we view with a certain amount of pleasure that they are now attempting to make a *volte-face*. They have at last realised that, in the last analysis, their main wealth is derived from industrial activity and not from auxiliary and ancillary services, such as insurance and merchanting.

We are still not entirely satisfied with the present arrangements, however, as we consider that they are sufficiently powerful to create and maintain a panel of engineering and metallurgical experts who would advise the bank in cases where money was wanted for industrial development and the clients of the bank where an interest had already been established. At the moment they are certainly calling in both British and foreign consultants to advise them—a commendable practice no doubt, but it only provides a solution to one problem for one set of customers. A panel of engineers, attached to the banks, would be in a position to concentrate on the economic modernisation of plants, and if their advice were faulty and unremunerative, then a remedy is at hand. The consultant receives his fee for a studied report on a phase of activity and then, unless a retainer is accorded, leaves the works staff to hold the baby. There are cases where new companies are floated based on unsound engineering and metallurgical principles, yet, if a customer asks his bank manager whether it would constitute a suitable investment, he receives a non-committal answer bordering on the puerile. Surely they should be in a position to state that "their technical experts have not reported favourably on the proposition." This is equally non-committal but would be a pointer easy of interpretation, calculated effectually to check gambling on basically unsound commercial enterprises. A panel such as we propose need not be any real charge on the banks. It could be registered and conducted as a separate company on much the same lines as the new company sponsored by the Bank of England with the avowed aim of helping industry.

If the banks extend their direct interest in industry, they would do well to collect or assure access to collections of working costs, so that they could advise with real knowledge where each of their units can reasonably make remunerative capital expenditure. If the employers' federations had been sufficiently well supported and enterprising, most of these duties which we have assigned to the bank as being essential to the conduct of good business would already be redundant.

XUM

Copper Producers' Dilemma.

By "Onlooker."

So fraught with awkward possibilities is the future of the copper situation that any statement upon the conditions momentarily obtaining is likely to stand in need of drastic revision before ever it appears in print. Just as activity unduly prolonged leads to stagnation, so equally often does immobility frequently compel disastrous and headlong movement if it continues for an unnaturally long period. For twelve months the American copper combine, known as Copper Exporters Incorporated, "pegged" the price of their product at 18 cents while consumption dwindled, and stocks of refined metal increased from 55,000 short tons to quarter of a million, until on April 16, a year to the day since the previous reduction, the price slumped by 4 cents per lb. to 14 cents.

It may be surmised that such a drastic cut was only made after due deliberation and after every other possibility had been canvassed and dismissed as impracticable of achievement. Around the council table one may imagine those who looked askance at a price reduction, arguing that sales would not be increased thereby, whilst others, pointing out that cheap offers of copper were already rampant, maintained that no optional course remained and stressed the necessity of one bold cut which would rope in even the most timorous buyers. What has happened? For once in a way the advocates of the "sit tight" method have proved to be correct, or at any rate nearer the truth than those who plumped for action. Sales have been on a very meagre scale, and since the eyes of consumers have been fully opened to the direful difficulties confronting the producers it may with a good deal of truth be postulated that the last state is worse than the first.

Curtailed Output.

What will be the producers' next move? Round their necks like a millstone they have enormous stocks of unsold copper which have to be disposed of in addition to current production. Further curtailment is almost unthinkable, and it is extremely doubtful if such a course would be popular, for suggestions are heard that an increase rather than a decrease of output will be seen during the next six months. At what price will the consumers be content, for trade is bad all round, to take over from the producers a round 150,000 tons of refined copper? That is what the situation amounts to, for to obtain real relief from an onerous burden and freedom to produce again at a normal rate, reserves must come down to 100,000 tons, or very little more. Fourteen cents has proved a failure; will 12 cents be more successful? Perhaps electrolytic copper will stand below £50 before the tide turns and buyers summon up sufficient courage to go for a "long book."

There have been times before, during the past few years, when copper fell to remarkably low levels. The autumn of 1923 and the early months of 1927 are two fairly recent examples, but at that time trade generally was not so poor as it is to-day, and traders and manufacturers viewed the future with less pessimism. On both of the occasions quoted, electrolytic copper fell to round about 12 cents, but its stay at that level was short-lived, and, supported by a generous demand, the quotation very quickly recovered. To many people the copper stage appears to be set for a tragedy precipitated by the Exporters in maintaining so stubbornly a price-level quite out of touch with economic considerations.

Price-Cutting Losses.

One hears a good deal about the enormous loss entailed upon the producers of copper in facing a cut of £18 per ton on stocks of nearly 200,000 tons above normal, and the fact that a further price reduction would automatically increase this loss is argued as a reason 14 cents should be retained. What about the merchants, scrap dealers, manufacturers and ultimate consumers, who have to face—with reserves not nearly so adequate as those possessed by the copper kings—depreciation on every ton of stock in warehouse and workshop? Can they, harassed by taxation and working on a margin of profit cut to the bone by acute competition, afford such a setback? £18 per ton is bad enough, but if worse is to follow it may well be that some of the weaker units will be broken under the strain, while even the strongest must take years to recover.

While the more generous-minded would suggest that the Copper Exporters Incorporated have misjudged the situation, there are plenty who will maintain that it has been grossly mishandled through anxiety to wring the last drop of profit out of consumers. At no time during its existence has the American combine been popular, but it is probably safe to say that in its fourth year dislike has been changed to something a good deal stronger, and that, given a referendum, only a small minority vote would be recorded in favour of its retention. Limited quotas, insistence upon payment of a premium when delivered weights are taken, and extras for small lots are some of the impositions insisted upon by the Export Association which make consumers regret the time when merchants figured more prominently in the picture than they do to-day. At 14 cents there may be some reason for an association to maintain prices, but if the quotation is coming down to 12 cents or even lower it is difficult to see what justification there is for retaining the combine. As a matter of fact if the price does break 14 cents the Exporters' Association will probably break with it, and we shall then see how the situation will develop unfettered by rigid price control.

Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

The Morgan Crucible Company Reconstruction.

To the Editor of The Foundry Trade Journal.

Sir,—On page 390 of your May 22 issue, under the heading "The Morgan Crucible Company, Limited," reference is made to the scheme of reconstruction recently sanctioned by the Court. An error has slipped into the last paragraph, where it is stated that "As regarded the shares quoted on the Stock Exchange (*i.e.*, the first and second preference and preferred ordinary), the £10 shares were to be converted into pound shares, holders of £10 shares receiving fifty £1 shares for every £10." This should be ten £1 shares for every £10.—Yours, etc.,

For the Morgan Crucible Company, Limited,
H. C. F. Adams,
Secretary.

Battersea Works, Church Road,
London, S.W.11.
May 23, 1930.

French Papers and the Cleveland Convention.

In our issue of April 24 we commented, when dealing with the programme of the Cleveland Conference of the American Foundrymen's Association, that the official list did not include any Papers from France. We are now assured by the Association Technique de Fonderie that an official Exchange Paper by Mr. Girardet was submitted, though rather late. It dealt with some simple and practical methods for evaluating cast iron, the control of mould making and a new process relating to the metallography of graphite. Moreover, a Paper by Mr. Ronceray, dealing with the gating of castings, was also omitted from this official list which we printed.

Random Shots.

Someone asked me the other day whether I had thought about summer holidays yet. As a matter of fact, I had not, but I reminded him that "Marksman" and his kind never do go on holiday—officially. It is only the aristocrats of my profession who can command the magic words:—"Mr. X—— Y—— is at present on holiday, and will resume his literary causerie"—or his racing notes, as the case may be—"next week." None the less, I have been speculating as to what would happen if I did leave "Random Shots" to the tender mercies of someone else. Suppose, for instance, I were to ask my friend the Editor to take the job on?

* * *

The result, I fancy, would be something like this. "We find ourselves required at the present time to re-orient our mind and determine a directional treatment suited for the occasion. We are in an unfamiliar 'milieu' in this column, and we hesitate to occupy it with commentation on personalities which would, we know, arouse the interest of every foundryman. When it is a matter of a distinguished foreign visitor, such as our friend Dr. X——, we should easily find humorous remarks to make *en résumé*, but we are afraid, etc., etc."

* * *

On the other hand, if the Editor were in a somewhat different mood, he might set out to work thus:—"It is a matter for serious reflection on the part of our readers how far they are wise in subjecting themselves to a humorous discussion of serious topics. 'Life is real, life is earnest,' and there would appear to be some who are inadequately aware of and even slightly derisive of this fact. At a time when the whole nation groans beneath the burden, etc., etc."

* * *

Alternatively, one of our scientific contributors might have a shot. (Sorry, I didn't mean that!) What would he do about it? "During the week a number of tests on a new hyper-eutectoid sub-pearlitic iron have been made, with interesting results (which, of course, will not be given to the public until they have received the blessing of the Iron and Steel Institute at its Timbuctoo meeting three years hence). It is also rumoured that certain of the sands at present being tested under the auspices of a research association have been discovered accidentally to have valuable nutritive properties. They will probably be put on the market as the new vitamin XYZ foodstuff. An interesting side-line of scientific research."

All things considered, I don't think I dare take that holiday!

* * *

I have always been readily aroused to wrath over the claims of the Correspondence Schools and other purveyors of potted wisdom, but I must admit they have their humorous side. As, for instance, this extract from an American advertisement of a new and invaluable book (I quote from a recent volume dealing with American conditions):—"Husband (to wife, on way home after a party): 'Darling, I was so proud of you; you were so witty and so *original!*' Wife: 'But, darling, you, too, can be original; you have only to buy So-and-so's new book, and for two dollars you can have all the original ideas you want!'"

* * *

Marksman's Bulls'-Eyes.

There's nothing either good or bad, but drinking makes it go.

A woman's idea of economy is spending a shilling to save sixpence.

Too many modern plays are full of half-witticisms.

Marksman.

A British Exhibit at Cleveland.

Of the pattern-shop and foundry equipment exhibited during the American Foundrymen's Convention at Cleveland, Ohio, May 12 to 18, a machine that attracted much attention was a patent pattern-milling machine known as the Wadkin semi-auto pattern miller, and shown by the patentees and manufacturers, Wadkin & Company, Leicester, England, in collaboration with their American agents, the Oliver Machinery Company, Grand Rapids, Michigan.

The labour-saving possibilities of this machine are of considerable interest to those engaged in the production of engineers' patterns. Not only does the speed of working and the ease of handling the machine suggest big output capacity, but the extensive range of operations and the wide variety of different and complex jobs that can be done would unmistakably lead to big reductions in pattern-making costs. Many of the intricate jobs which were demonstrated on the stand in a few minutes would have taken a skilled patternmaker hours to accomplish in a shop where such a machine was not available. The makers claim that costs can be reduced by as much as 70 to 90 per cent. by the use of this machine. After seeing the practical demonstrations the truth of this claim might hardly be doubted. Some idea of the speed of the machine can be gathered from the fact that the actual cutting time for the corebox-making job seen in Fig. 1 was approximately 5 minutes.

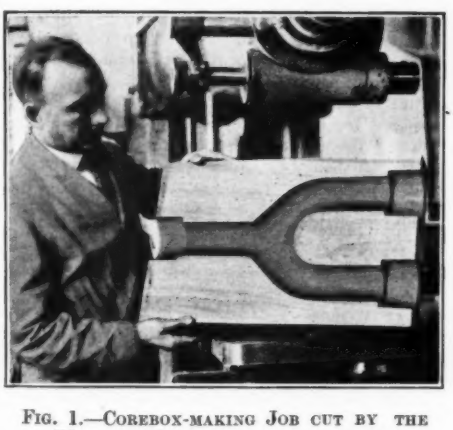

Fig. 1.—Corebox-making Job cut by the Wadkin Machine in Approximately 5 Minutes.

Construction Details.

In construction the machine consists of a main frame carrying an overhanging arm which may be raised and lowered by either hand or power motions. The attendant operates the hand motion, and an adjacent lever controls the power motion. The machine is driven by a 5-h.p. electric motor, coupled to a 3-speed gearbox bolted to the side of the main column. All the gearing in the gearbox is of steel with machine-cut teeth, and the controls are definitely located by means of ball plungers. The gear shafts are mounted on ball bearings, and this gear permits the cutter spindle to be driven at 1,220, 2,230 or 3,940 r.p.m. The method of driving the spindle is by means of laminated belt passing up the inside of the main column to two pulleys, either of which may be engaged through the medium of a clutch to the horizontal shaft extending along the inside of the overhanging arm. From the end of this shaft the spindle is driven through spiral gear-wheels which are totally enclosed and run in grease. The spindle head is arranged to swivel from the horizontal position downwards and backwards through 180 deg. The principal angles for the swivelling motion are marked, and a tapered spring plunger is provided to index the positions. Intermediate angles can be secured by means of a locking handle. Heavy ball bearings support and take the thrust of the spindle. The spindle, it will be noticed, lies below the level of the arm and therefore is well situated to enter a core box with its axis parallel to the surface of the work, without entailing the use of long boring bars. The starting, stopping and reversing of the cutter spindle are controlled from the hand-wheel at the end of the overhanging arm, which hand-wheel operates the two belt-pulley clutches by means of a rod passing through the horizontal driving shaft. A similar arrangement of clutches and endless belting is used to give the power motion for the overhanging arm. The cutter spindle has a feed of 3 in. within its housing, this feed being applied by means of a hand-lever mounted at the end of the overhanging arm co-axially with the main control wheel. This feed is provided with a spring plunger and also with limit stops to define and limit the feed motion. The cutter is capable of being quickly reversed by means of a hand-wheel on the capstan head, and by giving a partial turn of this hand-wheel the spindle may be started, stopped or reversed at will. All controls necessary for operating the head and the rising and falling motion of the arm are placed in a centralised position convenient for the operator.

Work-table Movements.

The work table is 35½ in. by 32 in. and is carried on a pedestal which can be moved by means of a hand-wheel along a pair of rails, 24 in. wide and 10 ft. long, forming part of the base of the machine. A plunger and a locking handle are provided to locate the pedestal in the central position. The top of the pedestal provides a seating on which the compound slides carrying the work table may be rotated. A plunger giving the principal angles and a locking bolt are provided for this motion. The ability to move the slides and work table into any angular position by means of this rotary adjustment is claimed to be very useful for certain operations and frequently to dispense with the necessity for re-setting the work. Rotary movement of the work for feeding purposes is not obtained from this circular adjustment, but by rotating the work table relatively to the compound slides. This movement is obtained by turning a handle projecting from beneath the work table, which handle is also used to operate a plunger giving the principal angular positions of the table relatively to the compound slides. The compound slides are operated by two concentric hand-wheels connected to screws. The nut engaging the cross-motion screw is split and can be disengaged from the screw by means of a push-and-pull rod. When it is disengaged the table can be floated to and fro by hand on the ball bearings with which this motion is provided. It is claimed that the ability to move the table crosswise in this manner by hand is very useful when light work is being dealt with. Spring and dead stops are fitted to the slide motions of the table and standard, and contraction scales are provided whereby the limits of the motions may be properly set.

We are given to understand that since the last Convention held at Detroit in 1926, when this machine was exhibited for the first time, a number of machines have been imported into the United States. To-day many of America's largest plants are using them, in addition to the large number of those firms who are using the earlier model known as the Wadkin Universal Woodworker.

Painting Machined Faces.—The machined faces of iron castings can be protected from rust if painted with a mixture of 3 parts of whitening to 2 parts of linseed oil. This can be easily wiped off when necessary, and leaves the machined face quite free from rust.

Transport Project for Falkirk Foundries.

Some time ago the Falkirk, Grangemouth and East Stirlingshire Publicity and Development Association interested itself in the establishment of a road-transport service between the Falkirk area and the large commercial and industrial centres in England. A local haulage contractor was encouraged to give the project a trial and within a short time the Association realised that they had been instrumental in providing a nucleus of something of greater importance than had been intended at such an early stage. Following a meeting between the executive of the Association and the contractor, it was ultimately agreed that a company should be formed for the purpose of developing road transport on the lines already adopted.

The secretary of the Association points out that the system of regular road transport will prove a boon to the local ironfounding industry for a variety of reasons. With an adequate fleet of motor lorries at its command the company can undertake to deliver goods direct to the consignee with a minimum of breakage and delay. This consideration alone should weigh materially with those desiring a rapid and direct service of transport to the larger towns in England, for goods conveyed by rail in the ordinary fashion are often delayed in transit not only during the actual journey but in loading and unloading in the goods yards of the company. This delay will obviously be completely eliminated by the new system, which has been favourably received by the majority of the local ironfounding concerns. One or two iron companies have not yet committed themselves, but they are watching with great interest the progress which is certainly being made. As a conclusive proof that there is a keen demand for a more facile method of transport than exists at present between Falkirk and the English manufacturing centres, several large orders have actually had to be turned down by the contractor as his vehicles were already employed to their full capacity. There is every prospect, therefore, that the formation of the new company will synchronise with an increased trade between Falkirk and the South. It is intended that the service will not be of the one-way variety. Having unloaded their freights at English destinations, the lorries will be able to convey back with them to Glasgow, Edinburgh or adjacent towns manufactured goods which would otherwise be despatched from England by rail. When arrangements are completed the company hopes to have road-transport services operating from Falkirk to Manchester and to Leeds and Bradford. Journeys to areas as far south as London will later be arranged.

New Companies.

Jeffrey Foundries, Limited.—Capital £1,000. Directors: A. Jeffrey, A. K. Jeffrey, both of 3, Thornton Road, East Sheen; and J. G. Simmonds.

Cindal Metals, Limited.—Capital £20,000. Manufacturers and refiners of aluminium, etc. Permanent directors: D. R. Tullis, "Aillig," Campbell Drive, Bearsden, Dumbartonshire; and P. Oakley.

Glover, Edwards & Company, Limited, 8, Laurence Pountney Hill, London, E.C.—Capital £12,000. Engineers and founders, etc. Permanent managing directors: A. Glover and F. Edwards.

Gloucester Foundry, Limited, Emlyn Foundry, Gloucester.—Capital £45,000 (20,000 6 per cent. cumulative preference and 25,000 ordinary), to acquire the business of ironfounders formerly carried on as F. H. Lewis & Company, at Wolverhampton, and by the Gloucester Railway Carriage & Wagon Company at Emlyn Works, Gloucester. Directors: T. Potter and A. G. Watkins.

Electrical Insurance in Foundries.

By "Engineer."

Electrical insurance differs from all other classes of insurance, in so much that it includes the periodical inspection of the plant insured and the issuing of reports upon its condition after each inspection, and also in case of breakdown, the supervision of repairs and witnessing tests after completion. The question of insurance with inspection of electrical apparatus is one which should be seriously considered by all owners of electrical plant in foundries. This applies to every class of electrical apparatus irrespective of type and size. It has been the writer's experience that breakdown is liable to occur even in cases where the most scrupulous care has been taken in the manufacture of the plant.

These breakdowns, however, may be minimised, if not altogether obviated, by the periodical inspection of the plant by expert engineer surveyors. In the course of the examinations carried out by engineer surveyors employed by an insurance company, they are able very often to detect developing defects which have been unnoticed by the staff in charge of the machines or apparatus. This may be due to the fact that a slowly-developing defect is not readily detectable by the machine operator, as the rate at which the fault develops may be scarcely noticeable from day to day, but the development of the fault in the course of two or three months may be considerable, and would, therefore, probably be detected by an expert engineer, if he had made an examination of the machine previously.

It may be of interest to quote briefly the various regulations covering the use of electricity in the order in which they have been formulated. The first regulations for the supply of electricity were the Electric Lighting Acts, 1882 and 1888. By the year 1910 the use of electrical power had developed to such an extent that the Board of Trade considered it essential to issue regulations in connection with its supply. The Home Office also considered it necessary to issue regulations for the use of electricity in factories and workshops. The majority of these regulations can be easily complied with and should in every case where they apply be put into force.

Insurance Procedure.

If the power user wishes to safeguard himself against electrical breakdown, loss of output, possibility of prosecution for non-compliance with the various rules and regulations covering the use of electricity, the best way he can do this is to take out a policy or policies indemnifying him against loss due to breakdown of his electrical plant. The first procedure, of course, is to communicate with a company which transacts engineering insurance business, giving them full particulars of the plant concerned, together with the values of same; it is essential that the horse-power or kilowatt capacity of the machines be clearly stated, and, if possible, information such as the speed and voltage of the machines should also be supplied. Upon receipt of this information the insurance company will send a quotation stating the premium which would be required to cover the plant against breakdown under a standard policy up to the limit of the indemnity required.

If the quotation submitted is accepted, the insurance company will send one of their engineer surveyors to make an examination of the plant, and a full report of its conditions is sent to the owner in due course.

If the plant is found to be in satisfactory order, a cover note is issued stating that the insurance company are holding the insured fully covered against breakdown as from a certain date. If, however, on the other hand, the plant is found to be in an unsatisfactory condition, certain recommendations are made in the report to remedy the defects, and it is advisable, of course, for the owner of the plant to carry out these recommendations in his own interests. In certain cases the carrying out of the recommendations must be done before cover be issued; in other cases, where the recommendations are not of vital importance, cover will be issued provided the recommendations are carried out at the first convenient opportunity.

When a breakdown occurs to a machine of special design or construction, it is generally advisable to send it back to the makers for the repairs to be carried out, and, in the event of the machine being insured against breakdown, such repairs are supervised by the resident engineer surveyor in the district where the maker's works are situated. He is, therefore, able to watch the progress of the work and witness the final tests upon the machine before it is returned to the owners; thus allowing the engineer to give the whole of his time and attention to the plant in the foundry.

This service on the part of the insurance company is a particularly valuable one when we consider the breakdown of switchboard instruments.

In such cases it is always advisable for the apparatus to be sent to the makers for repair so that the instruments can be correctly calibrated and thoroughly tested before they are returned.

With regard to repairs of an ordinary nature, these can generally be carried out locally, but here, again, it is advisable for such work to be supervised and suitable tests to be applied to the machines before they leave the repairer's works.

All-Important Financial Standpoint.

It may be of interest to consider the question from the financial aspect. Take the case of a 50-h.p. motor. This may be insured against breakdown for any sum from £60 upwards, but it is doubtful if so low a figure would give adequate cover on any but the cheapest type of squirrel-cage motor. If, however, the owner only requires the machine to be covered for the minimum amount, he may be called upon to pay any excess of the £60 indemnity in the event of a serious breakdown necessitating the complete replacement of the machine. Even then this does not take into account any damage which may have been caused to the starting switch. It will, therefore, be seen that it is generally advisable to take the cost of the starting switch into consideration when stating the indemnity required.

Consider, further, that the breakdown may occur within three months of the inception of the policy, leaving nine months to elapse before the renewal date, the inspection service would still be continued, but in the event of a further breakdown he would have to meet the cost of repairs unless he had renewed the insurance by paying an additional premium on the basis of the original premium *pro rata* to the date of renewal or placed a higher indemnity on the machine in the first place.

Whilst it is unlikely that a total breakdown of both motor and starter will happen which necessitates their entire replacement, it often happens that two or more breakdowns of a less costly nature may occur which in the aggregate may cost more than £60.

The question, then, becomes one of whether the owner is content to insure for the minimum amount and take a certain amount of risk of having to pay any excess of such amount in the event of a breakdown, or to insure for the full value of the plant, with practically no risk of being called upon to pay in the event of a breakdown.

Premiums and Indemnity.

The additional premium required for the larger indemnity is very small compared with the minimum premium for the minimum indemnity. This is due to the fact that the minimum premium has to bear the cost of inspection, while the additional premium for the larger indemnity is a matter of insurance only—i.e., the same expense is incurred in the inspection of a certain-sized machine irrespective of the amount of indemnity placed upon it. On the other hand, sometimes the indemnity asked for is very much on the high side; this may be due to the present price of a similar machine being less than when it was purchased and also to the fact that the whole of the installation costs have been included in the cost of motor and starter. Thus the indemnity may be so large that it would be extremely unlikely to be liquidated in any one year.

Perhaps the most satisfactory method of arriving at the amount of indemnity is to add together the cost of the motor and starter and then to take approximately 70 per cent. of this sum as the indemnity required. The standard electrical plant policy has been devised to suit the average owner of an electrical plant, and as such it gives adequate cover for breakdown of the machine or apparatus whilst at work, with certain standard exclusions, some of which may be covered for a small additional premium. For instance, the standard policy excludes: (1) Damage to bearings due to overheating; (2) wiring between the motor and starter, both of which can be covered if required, at a slightly additional premium.

Electrical insurance companies also undertake the examination of second-hand machinery prior to purchase, and the supervision of new plant under construction. Also the periodical inspection and issuing of reports on the condition of plant without insurance. In the course of their duties engineer surveyors examine many different types of electrical plant, and it very often happens that they are able to assist the operating engineer with some problem which may have arisen in connection with his plant. A similar case may have occurred in another part of his district, and the surveyor would then have fully investigated it, and would be thoroughly conversant with the remedy required or the method to be adopted, as the case may be.

Lanarkshire Industrial Depression.

The industrial outlook for the summer holiday period for the workers of Motherwell, Wishaw and Bellshill districts of Lanarkshire is anything but bright. A wave of industrial depression is sweeping over Lanarkshire and causing considerable hardship in business circles. At the end of May the number on the unemployed register is more than 1,000 greater than at the end of March, and there seems little likelihood of these 1,000 men receiving employment this side of the July holiday. One or two collieries have been closed, and Murdostoun Colliery at Clelland is being permanently shut down. In the local steelworks the working week is being curtailed, and a number of suspensions are taking place. At the Fullwood Foundry, a subsidiary concern of David Colville & Sons, Limited, where the main work is the casting of ingot mounds, about 100 employees have been suspended indefinitely. Many iron and steel works in Lanarkshire have had overtures made to them on behalf of Soviet Russia, and, quite frankly, these firms have admitted that they would welcome business if satisfactory terms of payment could be guaranteed.

Moulding and Casting.

By J. Ellis (Past-President of the Institute of British Foundrymen).

(*Continued from page* 348.)

Position of Core Plates.

Fig. 1 shows the safest way of placing the core plate B, which is well below the casting. It has happened that castings have been lost by the omission of this detail; should the plate B be too close to the casting, then there is the

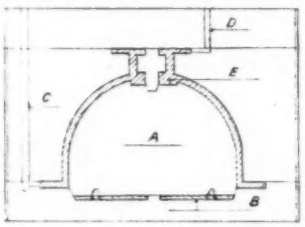

Fig. 1.

danger of contraction being impeded and the casting cracking. Even if the joints are not properly sealed, there is danger of the metal getting in the space and causing a fin, which may prevent contraction and cause the casting to crack. C is the runner and D the riser. E shows a very troublesome part; being at the top of the casting, there is very little liquid pressure there, and in consequence this part is generally unsound. Artificial means are usually adopted; chills, both externally and internally, are applied with great success.

Lack of Reinforcement Causes Waster.

Fig. 2 shows a sketch of a box-like casting; the first one made was a waster, because the moulder did not put the supports D in the

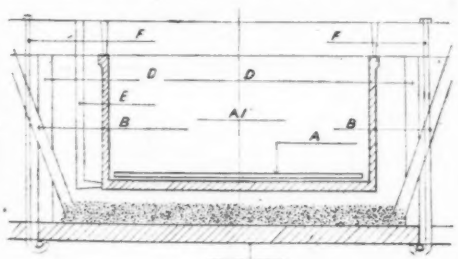

Fig. 2.

mould. The liquid pressure induced when the mould was filled caused the metal to run out at the joints. The whole top part had lifted, bringing with it the foundation bars also. The next casting was quite satisfactory; the support bars were put in place, engaging the top part of the moulding box; to that the box could be bolted down very securely, iron to iron, without fear of the top part lifting. A is the lifting grid for the inside of the mould, B the vent pipes, E the runner and F the hookbolts.

Use of Block Prints.

Fig. 3 will serve to show the advantages of block prints over loose chipping strips. One

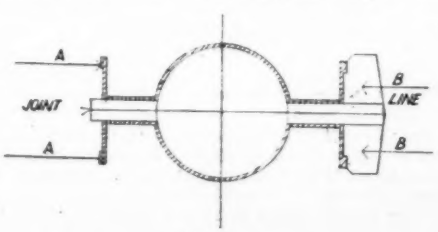

Fig. 3.

can easily imagine how difficult it is to draw those loose strips AA out of the mould from the joint; how much easier it is to have block prints BB. This system also ensures a better casting; yet one encounters patterns still being made with chipping strips.

Running Cylinder Castings.

Fig. 4 illustrates a large cylinder. By using top runners only, there is the danger of the

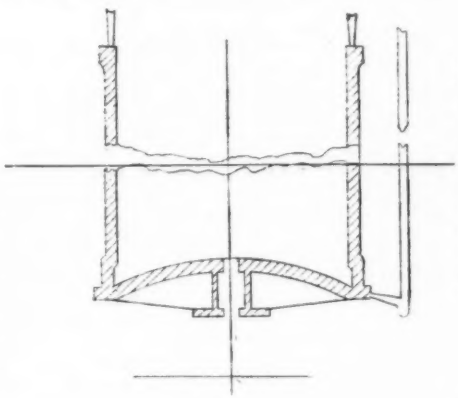

Fig. 4.

crown or bottom of the mould, as shown, scabbing by the force of the metal dropping from the top. This danger is avoided by pouring, say, a ton or so of metal in at the bottom. The ladle can thus then be taken away, there being no danger of the mould drawing air, because the metal is in the top runner; then the top plugs can be lifted and the major part of the metal let in and dropped into liquid metal, and so a good casting is secured.

Anchoring Cores and Sealing Joints.

It is of vast importance that these operations should be performed with a view to safety. As the whole inside of the mould, together with the foundation plate, must be lifted so that the moulder can get under it to bolt down the core. Never should this be allowed until the whole has been propped up; should anything give way when it is not propped, the men's lives are unnecessarily exposed to danger. In such a case the joints of the centre part should receive proper attention and thoroughly and completely sealed. Should the metal get a little start at the joint or core print (Fig. 5), it will very soon

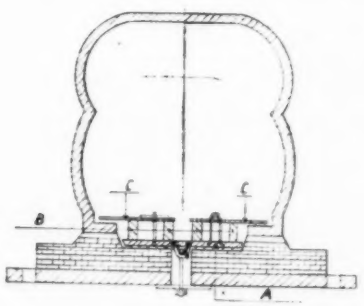

Fig. 5.

work its way through the hole provided for anchoring the core, when it is extremely difficult to stop it. A is the core- or lifting-plate, which must be provided with staples both top and bottom B, the block supports for carrying the overhanging grids, which in such a case are made in two pieces so that they can be taken out of the casting without breaking them.

Building a Condenser Mould.

Fig. 6 shows a condenser and the method of building up when moulded in the floor; very few are now so moulded. Proper moulding boxes are

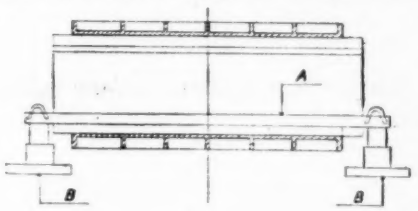

Fig. 6.

provided, which simplifies the moulding. One of the most important functions in the moulding of this class of castings is to build the core with the view to its rapid release after casting, as the contraction is so quick there is always the danger of contraction cracks. A is the lifting iron or grid, which must be very strong, as the whole core has to be lifted by this. It is also important to set the bearings BB to receive this core and allow of its being packed down securely. The core should be so built as to allow it to be easily broken away after casting.

Pipes without Chaplets.

Fig. 7 shows special method of making bend pipes without chaplets. The core iron A is extended beyond the centre of the core, thus

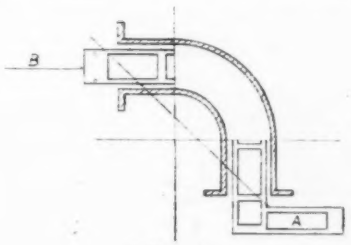

Fig. 7.

balancing the core and also preventing any movement by the upward thrust of the metal. B shows another system whereby the core iron is arranged with bolt holes in and corresponding holes or bolts in the foundation bearing-bar. Then the core can be securely fastened. These systems are only possible if the price of the resultant casting justifies the expensive core irons. Fig. 8 shows quite a common method con-

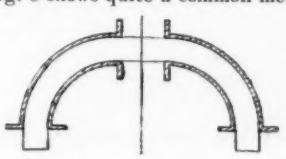

Fig. 8.

stantly in use in the Black Country. It makes two castings with one core, and is quite a good system, as the cores balance themselves and need no artificial supports. Fig. 9 shows another good

Fig. 9.

method. The core print A is carried to the outer diameter of the spigot end of the casting. This not only facilitates moulding, but also helps to make the spigot softer. This is appreciated if the spigot has to be machined and tapped.

Open Sand Plates.

It is very strange that the methods of the loam moulder should differ so much from those of the sand moulder when making open sand plates. The sand moulder makes his mould *below* the floor line as at A (Fig. 10), while the

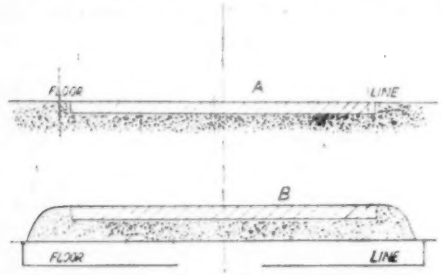

Fig. 10.

loam moulder makes his *above* the floor line B. The author has yet to see an open sand plate scab when made by a loam moulder. All open sand plates should be covered with sand to prevent the cold air attacking the top, while the bottom is quite free from air. Neglect of this detail has resulted in the plate cracking.

Pulley Castings.

Block prints to-day are very much to the fore, and no doubt are very efficacious, but the system can be overdone, as it was discovered better and cheaper castings could be produced by moulding the centre—as well as the outside—in sand (Fig. 11).

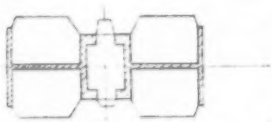

Fig. 11.

Lettering Castings.

Fig. 12 shows a boiler front. The name had to be stamped in with a set of loose letters. The right-hand sketch shows the mould and the letters

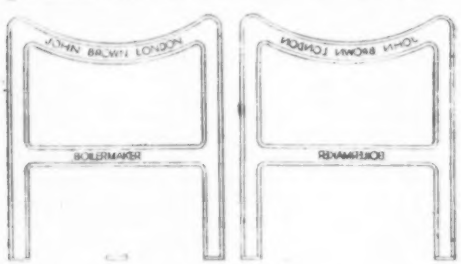

Fig. 12.

backwards, and in stamping these letters in backwards many mistakes were made. Of course this was 30 and 40 years ago. Now letters are attached to the pattern—so much easier to mould and no fear of putting the letters wrong way round.

Core Venting.

Fig. 13 shows what a lot of trouble was caused by the absence of wax vents. Vent holes had to

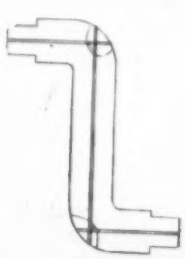

Fig. 13.

be drilled with a steel wire with a drill-like point revolved by the finger and thumb along the centre of the core; then the cross-vents had to be connected by either very fine ashes or pieces of string. Whilst one core was being vented in this way, in the good old days, three or four completely vented cores are made to-day. Fig. 14

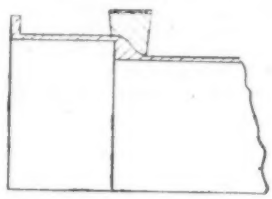

Fig. 14.

shows part of a large turbine casing. It can easily be seen that the part most likely to give trouble is the first expansion of the section, which is so very much thicker than the other parts. To endeavour to get this part as sound as the other parts, a chill was made of cast iron and placed in the mould, as seen in Fig. 14. This chill weighed about 3 cwts., and a very curious thing happened to one of them after the casting was taken out of the mould. The chill showed unmistakable signs of having been melted. The top of the chill, which originally was flat and fairly smooth, was, when taken out, rough and wavy—obviously having sunk. The opinion of everyone who saw it was that the only thing that saved the chill from fusing on to the casting was the plumbago dressing. One can say that the chill was not melted while the mould was being poured, but, as soon as the mould was filled, the chill melted, and so the division was brought about by the dressing only.

Burning-on.

Many metallurgists condemn burning-on, chiefly because they think there is bound to be undue strains on the other parts of the casting treated. The author thinks that the burning-on of a steam cylinder (Fig. 15) is one of the best

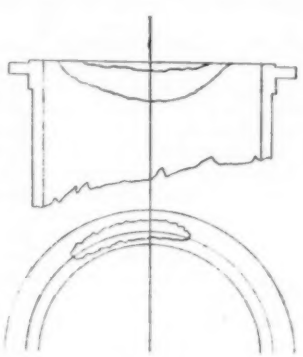

Fig. 15.

jobs that has ever been undertaken. This cylinder—about 5 tons—was cast inverted, and had a head of about 18 in. It seemed quite a good casting when it left the foundry, and even when the head was cut off, it was sound. All other parts were then machined, and, when the finishing cut was taken on the flange A, a defect was revealed as indicated. The metal had simply dropped away like a big draw; it is not usual to see such a defect on cylinders when a header had been applied. The defect was fairly large, and extended down into the core, as indicated. This was burned most successfully and as deep as the lower line. No one could tell it had been burned, except those well acquainted with the burning-on process. The all-important factor governing the success of this process is to get the casting as near melting-point as possible, yet not enough to cause distortion—not a local heating-up. This is where so many foundrymen fail. This local heating is sure to put uneven stresses on other parts of the casting if it does not crack the casting.

The casting (Fig. 15) was heated up all over gradually, and then brought up to the critical point; then the new metal was poured on to the defect, the whole covered over with blacking and backed up with hot coke, then finally dry sand, and left to cool gradually. This cylinder was burned 10 years ago, with the consent of the owners, and is still in use to-day.

Fig. 16 shows another case of successful burning-on. This was a broken flange of a large

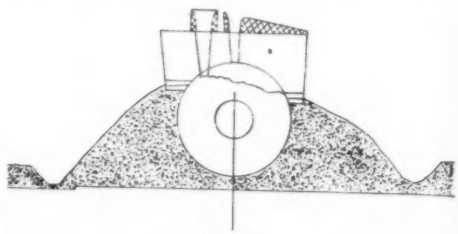

Fig. 16.

casting. The whole casting was made hot in the usual way and a loam cake was fitted on to the casting, as shown. The runner was placed so that the metal would drop on the highest part of the broken flange, the hot liquid metal would readily flow down to the small flow off, shown on the right, whilst at the same time the flange on the opposite side would begin to melt until the new metal would flow out of both flow-offs. When the metal flowed freely from both, it was then stopped up with a bot and a little metal poured through and out of the riser so as to wash out any scum. Then the whole was covered as before and left to cool gradually. This was another very successful burn-on.

There is no doubt that burning-on, intelligently carried out, will save the jobbing founder hundreds of pounds annually.

Runner Basins.

The top sketch of Fig. 17 is generally acknowledged to be a very good one, the well A holds

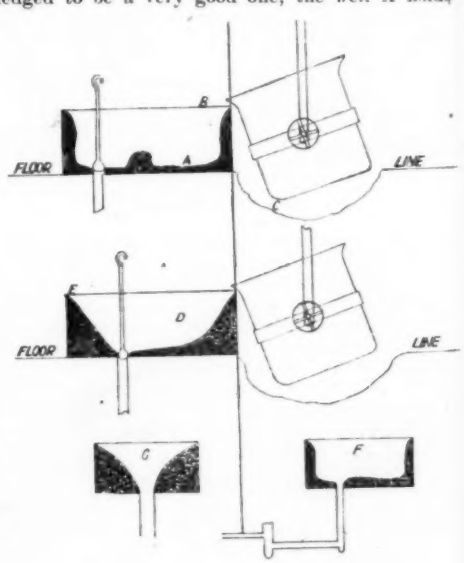

Fig. 17.

enough metal, if poured in slowly, to ensure a good start. The lip of the ladle is brought as near the edge of the runner box as possible, as at B. This being so, it has happened that the bottom of the ladle fouls the ground C, and so spoils an otherwise good cast.

The runner basin D is considered a very bad

(*Continued on page* 408.)

Malleable Cast Iron.*

By G. R. Shotton and H. G. Hall.

Although the manufacture of iron castings has been carried on for a number of centuries, the production of castings that are malleable is of much more recent date. At the beginning of the eighteenth century three kinds of iron were in use. These were wrought iron—soft, and worked only for forging; cast iron—brittle, and worked by casting; and crucible steel—nearly always forged to shape.

Of these three kinds, not one combined the property of malleability of wrought iron and fusibility of cast iron; that is, no material had been found which could be cast into intricate shapes, and which would also be malleable when completed. Naturally, the problem of producing such an iron had long intrigued the iron-founders, and it was in 1722 that Réaumur com-

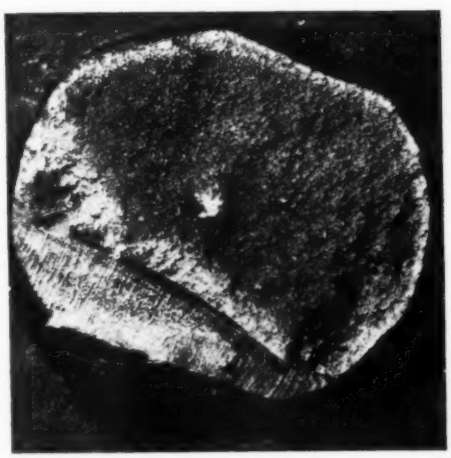

Fig. 1.—Fracture of Annealed Black-heart-type Malleable. Dia. of bar 1½ in.

menced the production of malleable castings in Europe. His method was to pack small castings of white iron in small nodules of iron ore and to heat them up to a good red heat for some days.

Probably this method was suggested to him by the steel cementation process, for instead of adding carbon by means of charcoal he removed carbon by means of iron ore. From Réaumur's discovery a large industry rapidly grew in Europe, namely, that of the white-heart malleable industry. The origin of black-heart-type malleable cast iron, however, was in America, being discovered quite unconsciously by Seth Boyden, who was attempting to use Réaumur's method in Newark.

Apparently, in attempting to duplicate European practice whilst using American pig-iron, which was low in sulphur and high in manganese, that is, the exact opposite of most European pig-irons, which were high in sulphur and low in manganese, he produced an iron which, instead of being decarburised during annealing, actually graphitised. Yet it was many years before Seth Boyden or his associates realised that decarburisation was not essential to the production of black-heart-type malleable cast iron.

When one realises, however, that Seth Boyden's discovery was not the result of a logical metallurgical development, but more of an accident, and that most of the work done on malleable cast iron was done at a time when analysis of iron was unusual, it can be readily understood that there were many misconceptions as to the proper method of manufacture. Naturally, then, at times, batches of very inferior cast iron were produced; iron which was very brittle; iron which would not machine readily, and iron which could not even claim the properties of ordinary grey cast iron. This early unreliability prejudiced engineers against malleable cast iron. Since then, however, the study of the production and properties of the material has been developed, and the mechanism of the process is now fully understood and has been reduced to an exact science. The engineer to-day, therefore, need have no fear as to the reliability of malleable cast iron produced under exact scientific control.

The vital difference between white-heart and black-heart-type malleable cast irons is that, although both varieties are quite brittle as cast, the former obtains its malleability from the oxidation of carbon, and the production of a type of steel, and the latter, by the graphitisation of the carbon into small nodules and the production of a wrought-iron type of structure. Naturally, as the names imply, this difference is distinctly noticeable upon examining their respective fractures visually. Figs. 1 and 2 show for comparison the fractures of black-heart and white-heart-type malleable cast irons respectively.

Fig. 1 shows the typical silky appearance of good black-heart-type iron, and as this sample

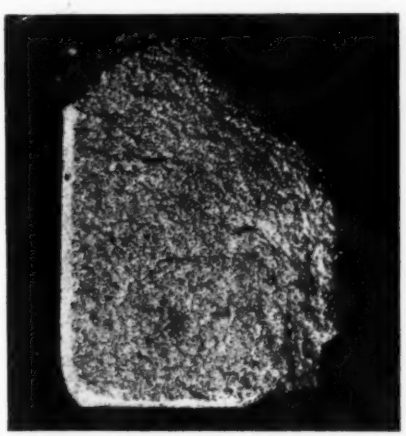

Fig. 2.—Fracture of Annealed White-heart Casting. Thickness of section ¾ in.

was originally taken from a round bar, its battered appearance, due to the difficulty of fracturing, affords good evidence of the ductility of the material. Also, this silky appearance is an essential quality of good black-heart-type iron—dull, coarse and open fractures being indicative of poor physical properties. When studying the two materials side by side under the microscope, however, the difference mentioned previously becomes very apparent.

Fig. 3 shows the structure of the edge of a piece of white-heart malleable cast iron. The extreme edge consists of completely decarburised iron, there being a progressive increase in carbon towards the centre of the casting, shown by a proportionate increase in pearlite, and it is at this point (see Fig. 4) that the similarity of this structure to that of mild steel becomes noticeable.

The structure here consists of temper carbon, that is, small nodules of graphite, ferrite and a small proportion of combined carbon, in the order of 0.4 to 0.7 per cent., which is diffused through the matrix as laminated pearlite. The similarity of the structure of black-heart-type malleable cast iron to that of wrought iron is well shown in Fig. 5.

In Fig. 5 the structure consists of nodules of temper carbon in a matrix of ferrite grains. This structure is uniform throughout the casting, with the exception of an extremely fine band of pearlite round the edge, as shown in Fig. 6.

It is practically impossible to eliminate this last trace of pearlite, but, as it is in the region of 0.05 to 0.10 per cent. carbon, as referred to the whole of the casting, the proportion is too small seriously to affect the properties of the material. White-heart cast iron, then, as a finished product, consists of a material in which the carbon content increases gradually from the edge to the centre, and which is therefore harder in the centre than towards the edge.

Black-heart-type malleable cast iron, however, as a finished product, consists of a uniform structure of ferrite and temper carbon. These irons, then, owe their properties to the combinations of constituents, and these particular combinations are determined by the chemical composition and heat-treatment of the alloys. To find the substances which are stable at different temperatures and the concentration of carbon at those temperatures, it is necessary to understand the iron-carbon equilibrium diagram.

How the White Iron Freezes.

In Fig. 7 the alloys with which we are mainly concerned in the malleable industry are those to the right of D*b*, that is, alloys of 2.0 per cent. carbon and over. Thus, the ordinary course of events in the freezing of a white cast iron suitable for the manufacture of a malleable casting, that is, of 2.5 per cent. carbon, would be as represented by the line XY. Freezing commences at N. The solid material formed is lower in carbon than the remaining liquid, that is, at temperature O, the alloy has a solid phase

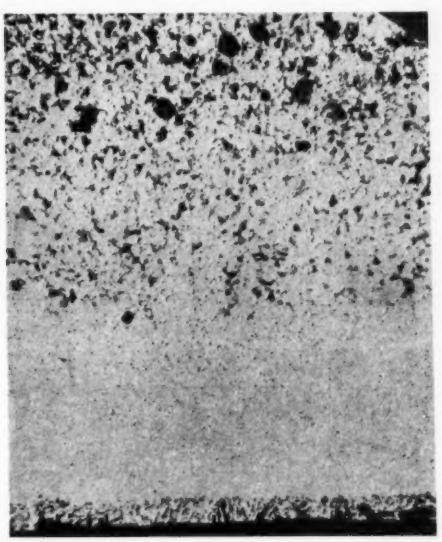

Fig. 3.—Edge of Annealed White-heart. × 150 dias.

of carbon content 1.25 per cent. and a liquid phase of carbon content 3.6 per cent.

At temperature M the remaining liquid freezes as eutectic. In freezing, however, this eutectic breaks up into cementite, and a solid solution of carbon in gamma iron, known as austenite. This latter contains 2.0 per cent. carbon, and is identical with the solid formed previous to the freezing of the eutectic. As the temperature falls still farther, the solubility of carbon in austenite decreases below 2.0 per cent., as shown by D*b*. Thus, at temperature R it consists of cementite and a decomposition product of austenite of carbon content 1.10 per cent., and finally at *e*, or 730 deg. C., that is, the A_1 critical point, the solubility of iron carbide

* Read before the Annual Meeting of the Birmingham Junior Section of the Institute of British Foundrymen, Mr. T. E. Gough presiding.

in iron becomes nil, and the remaining solid solution is converted into pearlite, so that now the material consists of pearlite and cementite. This is the actual course of events in the freezing of white cast iron in any malleable foundry.

This system is, however, a metastable one, and final equilibrium is only obtained when the iron has been maintained for a sufficient length of time at or above the lowermost critical point to convert the comparatively hard constituents of cementite and pearlite into the softer ones of graphite and ferrite. The ease of this conversion is facilitated by certain elements such as silicon and aluminium, and retarded by elements such as sulphur and chromium.

The range of analysis for a white-heart cast iron would be: T.C., 3.20 to 3.80; Si, 0.45 to 0.75; Mn, 0.30 to 0.40; S, 0.20 to 0.35, and P, below 0.10 per cent., whereas the analysis for a black-heart-type white cast iron would be: T.C., 2.30 to 2.60; Si, 0.75 to 0.90; Mn, 0.25 to 0.35; S, 0.03 to 0.06, and P, below 0.20 per cent.

The main differences between the two sets of analyses are those of total carbon and sulphur, and in connection with the latter it is interesting to note that, according to some authorities, good-quality white-heart castings cannot be made with low-sulphur iron. The difference in carbon content is due, in the main, to differences in

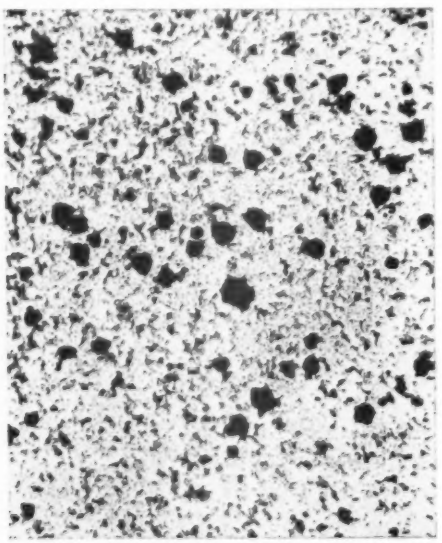

Fig. 4.—Centre of Annealed White-heart. × 150 dias.

melting practice between the two types of malleable iron, and is distinctly noticeable on examining the microstructures of the unannealed irons.

In Fig. 8, which shows the microstructure of unannealed white-heart iron, the structure is dendritic, and consists of hard white cementite in a ground mass of pearlite.

The unannealed black-heart-type iron shown in Fig. 9 also consists of pearlite and cementite, but it will be noted that, owing to the lower carbon content, the proportion of cementite is much less than in the previous figure, and that the structure is not nearly so dendritic. A rather noteworthy point about black-heart-type hard iron is that its tensile strength may be considerably over 25 tons per sq. in., and that it can be drilled if necessary.

Effects of Common Elements.

Comparing the effects of carbon on the two materials, it will be seen that in the case of white white-heart cast iron with a higher carbon content than usual, the annealing will have to be proportionately longer in order to obtain the necessary soft material, due to oxidation of carbon, but in the case of black-heart-type material it can be readily seen from Fig. 1, showing annealed structure, that the strength and ductility depends on carbon content being as low as practicable. This is in order to produce fewer temper-carbon nodules, and so upset the continuity of the ferrite structure as little as possible.

Influence of Silicon.

The effect of silicon is to favour graphitisation. It is usual to vary the silicon content inversely with the carbon content, that is, the higher the carbon the lower the silicon has to be, otherwise there will be a tendency for the production of primary graphite, resulting in a

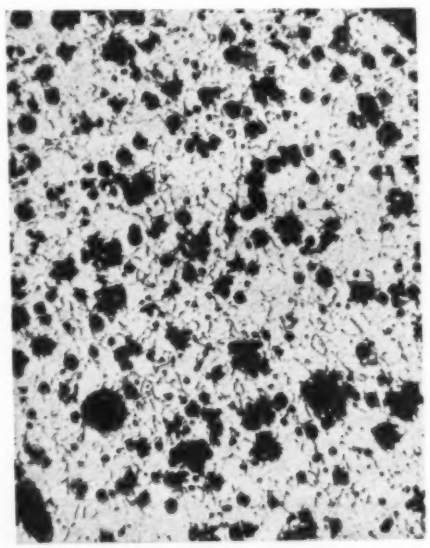

Fig. 5.—Centre of Annealed Black-heart-type Malleable. × 150 dias.

material which, when broken, would have a fracture such as is shown in Fig. 10, an actual photograph of a fractured feeder of 3-in. cross-section. The white background is the normal hard iron, consisting of pearlite and cementite, but the small grey patches consist of pearlite and graphite, the latter being of the flaky type ordinarily associated with grey cast iron. This

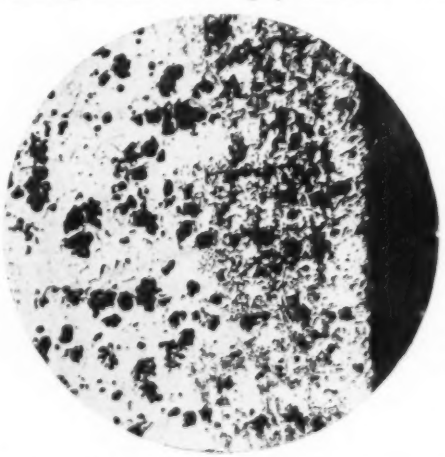

Fig. 6.—Edge of Annealed Black-heart-type Malleable. × 150 dias.

type of fracture must be avoided in both types of malleable cast irons, because such an iron, annealed under normal conditions, has a microstructure as shown in Fig. 11, which consists entirely of graphite and ferrite, the black lines being the graphite. It will be noticed that the graphite has grown during annealing to such an extent that it has almost surrounded the ferrite grains, meaning that the strength of the material depends on the strength of that graphite, which is practically nil. It can be seen, therefore, that such an iron would be comparatively rotten, and would be in no way superior in properties to an ordinary grey cast iron.

Effect of Sulphur.

Sulphur has a retarding effect on graphitisation, and is the controlling factor between the varieties of malleable cast iron, for if the sulphur in a white-heart casting be very low, thus allowing the combined carbon to graphitise easily during annealing, then the amount removed by oxidation is very small, and the final product possesses relatively poor physical properties, due to the flaky nature of the graphite produced at the high annealing temperature. Therefore, comparatively high-sulphur contents are allowable. In black-heart-type iron, however, the percentage must be low, in order to assure complete graphitisation.

How Manganese Acts.

According to the latest researches, the percentage of manganese present in white-heart iron should be sufficient to balance the sulphur, that is, manganese should be present in the atomic ratio of 1.72 times the percentage of sulphur. In black-heart-type iron, however, a slight excess is necessary, being in the order of 0.2 to 0.25 per cent.

Influence of Phosphorus.

Phosphorus can be as high as 0.2 per cent., but it is rarely found above 0.1 per cent. in white-heart iron, or 0.15 per cent. in black-heart-type iron. Above 0.2 per cent. it is not completely soluble in the ferrite, and begins to

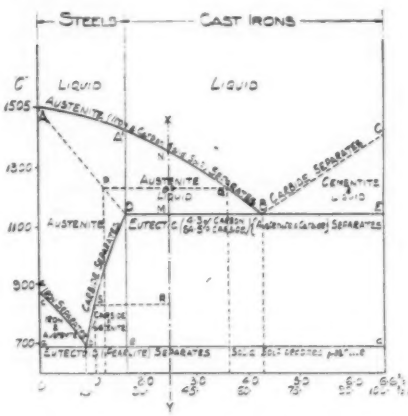

Fig. 7.—Iron-Carbon Equilibrium Diagram.

affect the properties, especially in the case of white-heart irons. It is interesting to note that black-heart-type irons containing 0.04 per cent. phosphorus and 0.16 per cent. phosphorus have commercially identical properties.

Melting.

From the effects of these elements it will be seen that control of the melting operations must, especially in the case of bleack-heart-type malleable cast iron, be very rigid. There are several commercial methods of melting malleable, consisting of air, electric and open-hearth furnace melting and cupola melting. Cupola melting is suitable for the production of white-heart malleable, but not for black-heart type. In fact, its use for the production of specification metal has been prohibited by the Specification of the American Society for Testing Materials.

These objections are based on lack of uniformity of product and lack of control, and as the cupola runs continuously, there is no method of controlling the composition prior to tapping, at least so far as high total carbon and sulphur are concerned.

The pig-iron used for the production of white-heart malleable is of two kinds, either refined iron or hematite iron. Most people prefer to use refined pig-iron, for, regardless of analysis, there seems to be a greater tendency for the pro-

duction of mottled-iron castings from a cupola charge with a hematite base than from one with a refined pig-iron base. The charge for the cupola consists, then, of pig-iron, hard scrap and often a small proportion of steel. The amounts vary, of course, with the cupola practice adopted, the latter having effect on the losses of various elements. The cupola practice is rather different from that of grey iron. The metal must be extremely hot, due to the rapidity of freezing of white iron. This necessitates the use of a good coke and the charging of a larger quantity than for grey iron practice. Usually a higher blast pressure is used. It is extremely difficult to control the analyses of cupola-melted material, so that it is necessary to standardise every procedure—that is, a certain method of charging must be adhered to. The pig-iron, scrap and steel must be correctly weighed, as must be the coke, and the blast pressure must be controlled.

The carbon content is comparatively independent of the mix used, depending more on the condition of the fuel bed. The silicon loss is usually about 0.2 per cent. The manganese

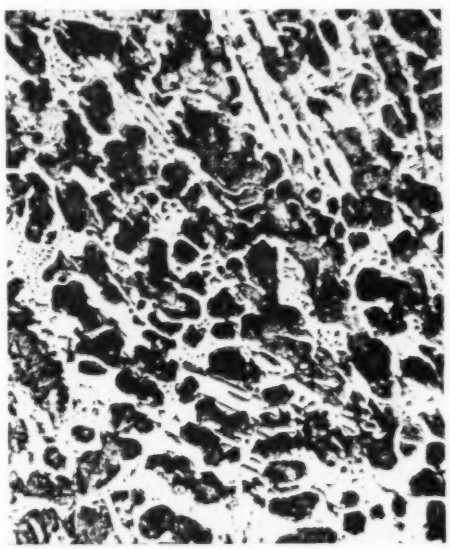

FIG. 8.—WHITE-HEART IRON, AS CAST. × 150 DIAS.

depends on the amount in the charge—the greater that amount, the greater the loss, and may be as high as 0.3 per cent. As the pig-iron used is probably refined iron—fairly high in sulphur, and the scrap is high in sulphur, the sulphur gain is not very great, whilst phosphorus remains fairly constant.

In the manufacture of black-heart-type malleable, melting is chiefly carried out by air furnace or open-hearth furnace, although some producers in America favour the use of a combination of cupola, converter and electric furnace.

Open-hearth Furnace Melting.

The essential difference between the operations for the production of steel and for the production of iron suitable for malleable practice is that in the latter losses by oxidation are kept as low as possible. The usual losses by oxidation and gains by absorption and concentration are:—T.C. minus 0.50, Si minus 0.45, Mn minus 0.20, S plus 0.004, P plus trace and Fe minus 1.60 per cent.

The composition of a suitable charge prior to melting would be:—T.C. 2.90 to 3.0, Si 1.25, Mn 0.50, S 0.04 and P below 0.2 per cent. This would give an analysis as follows:—T.C. 2.40, Si 0.80, Mn 0.30, S 0.044 and P 0.20 per cent. The scrap is the controlling factor in the charge, and is in the neighbourhood of 40 to 50 per cent., depending on the class of work.

The pig-iron is necessarily a good-class hematite, of which it is handy to have about three different analyses for convenience in adjusting for slight changes in melting losses. It is rather interesting to note that up to quite recently it was said that good-quality black-heart-type castings could not be made with hot-blast coke iron, and that charcoal iron was essential. It is very difficult to get to the root of this belief, unless it was due to the fact that charcoal iron, being produced at a fairly low temperature, was lower in carbon. However, at the present time there is much more coke iron used than charcoal iron.

Steel scrap is used to reduce the high carbon

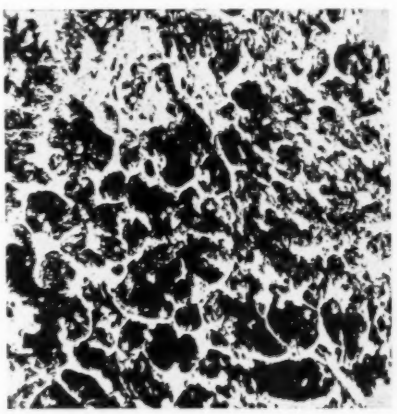

FIG. 9.—BLACK-HEART IRON, AS CAST. × 150 DIAS.

content of the hematite, and must be free from elements such as chromium and other inhibitors of graphitisation, as a small percentage of chromium would prohibit graphitisation in so much as to make it impracticable. The furnace is usually acid-lined, fired by producer gas, and undistinguishable from that used in a steel foundry, with the exception, perhaps, of size, the usual capacities in the malleable industry varying from five to twenty tons. The bath is fairly shallow, the depth depending on several factors—that is, it must not be so shallow as

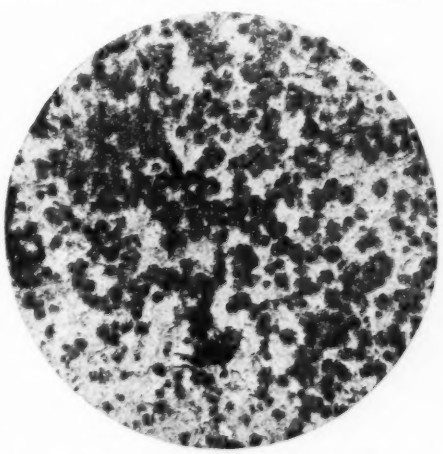

FIG. 10.—FRACTURE OF MOTTLED WHITE IRON, AS CAST. ACTUAL DIA. 3 IN.

to allow of "feather edges" and readily oxidisable metal, also, there must be sufficient slope towards the tap-hole to enable the bath to be drained fairly rapidly.

On the other hand, extremely deep baths are not favoured, owing to the long time necessary to raise the metal to a sufficiently high casting temperature. Usually the average depth is about 3 in., sloping to between 7 in. and 9 in. in the tap-holes. When charging, pig-iron is placed round the sides and breasts of the hearth, and hard scrap (that is, gates, feeders, scrap castings, etc.) is thrown in a fairly uniform layer over the centre. Finally, soft scrap (that is, annealed scrap castings) and steel are thrown on top of the scrap. The melting point of the above materials varies inversely with the combined-carbon content, that is, hard scrap tends to melt first, then pig-iron, soft scrap and finally steel. A good melter, however, so places his steel scrap that it is dissolved by the molten pig-iron. He will also endeavour to pull piles of unmelted material into pools of melted metal and so shorten the time taken to melt.

After melting, the metal consists of liquid iron and liquid iron oxide, Fe_2O_3. The latter, due to difference in specific gravity, floats on to the top and reacts with the carbon, silicon and manganese of the metal, forming CO_2, SiO_2, MnO, and being itself reduced to FeO.

The oxides of iron and manganese then combine with the silica to form an acid silicate, which dissolves some of the refractories in the furnace lining, and so forming a slag, protecting the metal from further oxidation. This slag, however, must either be kept very thin in order to raise the temperature of the metal to a suit-

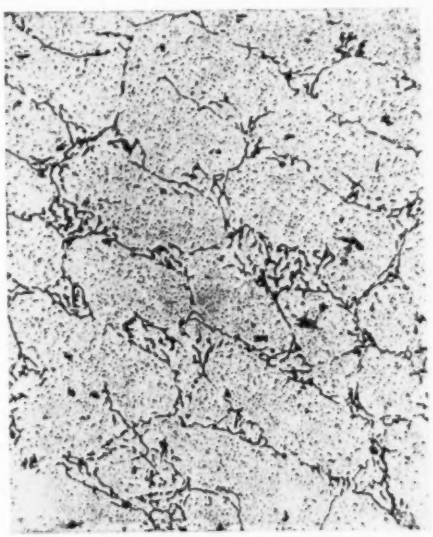

FIG. 11.—MOTTLED IRON AFTER ANNEALING, SHOWING GROWTH OF PRIMARY GRAPHITE. × 200 DIAS.

able casting temperature fairly easily, or it must be frequently skimmed off.

If the slag is drained off after the metal, then it is usual to add a few pounds of fluorspar before tapping to render it more fluid. A 5-ton charge usually takes about 3 hrs. to bring to the tapping temperature, while a 15- to 18-ton charge takes about 5½ hrs. The temperature of tapping should be at least 1,400 deg. C., and it is extremely important, firstly on account of the comparatively low "life" of the low-carbon iron, and secondly that, irrespective of composition, there is a greater tendency for the production of mottled castings from cold iron than from hot iron. It must be remembered that nothing is more detrimental to the final product than the separation of primary graphite in the initial casting.

It can be readily seen that in melting an iron such as is necessary for black-heart-type malleable cast iron, where the allowable chemical variation is very small, and yet which, unlike steel, does not allow of an analysis prior to tapping, it is essential to have good melting—that is, to endeavour, by a close study of the flame in the furnace, the eddy currents in the bath, and the appearance of the slag, to keep the oxidation losses fairly constant, and so ensure clean, hot metal. It is necessary constantly to repair the bath, and so make sure that there is no metal from a previous heat left on the bath, which would act in much the same way

as does hematite ore in steel practice when once the charge was melted.

Sometimes, due perhaps to adverse fuel conditions, the melting takes longer than usual, and as a result the losses by oxidation are increased. In this case it is necessary to counterbalance these losses by further addition of carbon, silicon and manganese to the charge. These are added to the bath in the form of pig-iron; 50 per cent. ferro-silicon and 80 per cent. ferro-manganese.

The Foundry.

The malleable foundry differs in few respects from the grey-iron foundry in so far as general lay-out and moulding procedure are concerned. The method of ramming and finishing a mould is essentially the same as in grey-iron practice. The main differences lie in the pattern equipment, in the location and size of the runners, and in the rate of pouring the mould. Moreover, the facing sand used has to possess certain definite properties, as follow: (1) As in grey iron, it must have good bonding properties and be sufficiently open in texture to allow of the free passage of the gases generated in the mould; (2) it must have a fairly high silica content, since the casting temperature of white iron is considerably higher than that of grey iron, and (3) on account of the sluggish nature of molten white iron, the proportion of coal dust in the sand must be carefully controlled.

An excess of coal dust in the mould for a light casting will invariably cause "misruns" due to the large amount of gas evolved being unable to escape quickly enough. Thus the flow of metal is chilled and retarded, and the mould is not completely filled. In the case of castings of a heavy section this factor is of little importance.

Pattern Equipment.

Since the hard iron possesses many characteristics which are not common to the general run of cast iron, it is obvious that pattern design and the size and location of runners will need special attention. The shrinkage allowance and other details of pattern design therefore depend on the following characteristics of the molten metal: (1) High melting point and low fluidity; (2) the total contraction is double that of grey iron, and (3) great tendency to internal shrinkage, due to the long freezing range.

Shrinkage allowance in the pattern must take into consideration the expansion which occurs on annealing. This is rather less than one-half of the original contraction. The contraction allowance in the pattern is therefore roughly $\frac{7}{16}$ in. per ft., but varies slightly according to the type of casting.

Fluid contraction, resulting in the formation of shrinkage cavities, is a source of trouble in castings of heavy cross-section, or castings with a thick section adjoining a thin section. The outer portion of the castings, which solidifies first, draws metal from the centre to make good the contraction which it undergoes during solidification. Thus there is insufficient metal left in the centre to fill up the voids between the dendritic skeletons, and a "shrinkage cavity" results. This can be remedied by the use of suitable "feeders" on the casting, the design and location of which are purely a matter of experience.

Fig. 12 shows the fracture of an annealed casting which exhibited a flaw due to uneven shrinkage in the mould. The fracture is that of a special form of black-heart, known as "picture-frame" material, and will be dealt with later. It clearly shows the manner in which the oxidising gases have penetrated the flaw, producing a band of low-carbon metal similar to that around the skin of the casting, thus showing very plainly the extent of the original flaw in the casting.

Castings with thick and thin sections adjoining are also liable to crack, due to the different rates of cooling. For example, take a wheel casting with a heavy rim and a light centre. The thin centre will cool fastest, and contract, with the result that, when the heavy rim begins to cool, its contraction is opposed by the centre, and the rim will tear or "fly." Immediately after solidification, therefore, a casting of this type should be rushed to a furnace, heated well above red-heat, and allowed to cool slowly, thus ensuring even contraction throughout the casting.

Spraying of Patterns.

Since a very large proportion of the work in a malleable foundry is small, and often has a large number of castings required from one pattern, "sprays" of patterns are very frequently used. The sprays of patterns are built up in the usual manner, but the runners and feeding heads are exceptionally heavy, as compared with the usual foundry practice. A form of "spinning gate" should always be provided to ensure that only clean metal enters the casting.

When very large numbers of a particular casting are required, the pattern may be mounted on a plate, complete with runners and feeding heads. Moulding may then be done by hand, or by the use of some form of moulding machine, many different types of which are used in the malleable industry. Undoubtedly the most outstanding feature of malleable foundry practice is the very large proportion of runners and risers necessary. It is common practice to melt from 35 to 40 cwts. of metal for every ton of casting produced. While this may appear excessive, it is, nevertheless, true that any attempt to cut down this ratio will only result in dirty, unsound castings.

Annealing Practice.

Before annealing, the hard castings are thoroughly freed from sand, for any sand left on the casting will "burn on" during annealing. Castings are also roughly fettled, all gates being broken or ground off. Since the annealing operation involves the use of elevated temperatures, there is a great tendency for the castings to sag or warp, unless they are adequately supported. The castings are, therefore, packed with ore, slag or a similar packing material inside large iron containers or "pans." The nature of the packing material depends on the type of malleable to be produced. In the white-heart process it must be of an oxidising nature, such as red hematite ore. In the case of black-heart-type material, however, it is essential that the packing material is non-oxidising, some such material as "crushed slag," "mill scale," etc., being usually used.

It is now the practice in some foundries, particularly in the United States of America, to anneal black-heart-type material without any packing material. This method, however, calls for very close control of annealing temperatures, and, what is of still greater importance, of a reducing atmosphere in the muffle. Possibly it is owing to these difficulties that the method has not yet been developed in this country. The annealing muffle consists essentially of a fire-brick chamber, suitably supported by tie-rods, etc., which is capable of being heated to the desired temperatures. Many different designs of ovens are being successfully used, the capacities of which vary from three or four tons up to twenty-five tons.

The muffles may be fired by coal, producer-gas or pulverised fuel, the two latter admitting of the closest control. The use of pulverised fuel is extending, but it is not economical unless it is used on a large scale, owing to the initial cost of drying, pulverising, storing and distributing the fuel.

The annealing pans are usually made of cheap white iron. Their size and shape depend on the class of work to be annealed, round pots of about 2 ft. in dia. being most common. Fig. 13 shows the method of packing the castings in the annealing pans. A base plate of white iron is supported a few inches above floor-level by means of two small stands, and the annealing pans are built up on top of this base plate, thus allowing

Fig. 12.—Fracture of Modified or "Picture-frame" Black-heart Iron, showing Internal Flaw. Actual dia. 1½ in.

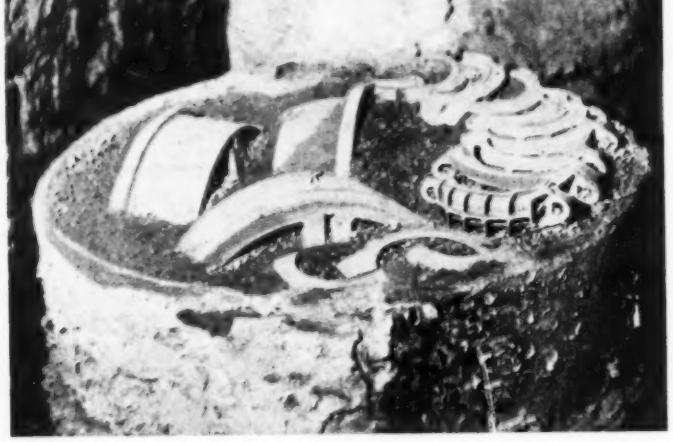

Fig. 13.—Castings partially embedded in Annealing Pans.

free circulation of the furnace gases below the stack of pans.

Before packing the castings in the annealing pans, a quantity of black foundry sand is first tucked around the sides and bottom of the lowermost pan to prevent access of furnace gases. On this is spread a layer of packing material, and then the castings are arranged on this in a manner best calculated to utilise all of the available space. Packing is then shaken in and lightly rammed all round the castings and to a depth of about an inch over them. More castings are then put in, and the procedure is repeated, until the stack of pans has reached the desired height, when a lid is placed on top of the uppermost pan.

The top of the stack and the joints of the pans are luted with wet black sand, to prevent furnace gases penetrating to the interior of the pans. (Fireclay is rarely used for luting the pans, as it has a tendency to crack off at the annealing temperature.) Barometric control of the ovens is essential if consistent results are to be obtained. Undoubtedly the best instrument for this purpose is an ordinary recording type of thermo-couple.

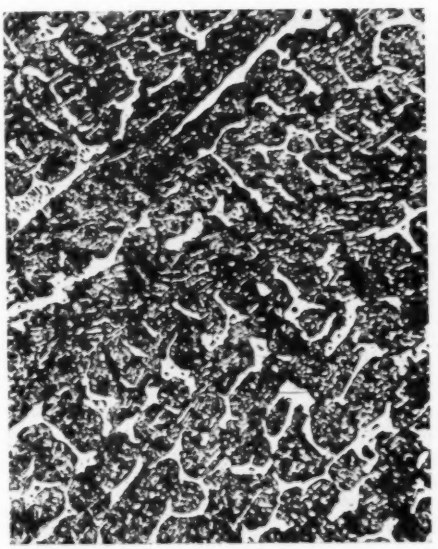

Fig. 14. — Black-heart-type Iron Water-quenched after Annealing for 2 hrs. at 880 deg. C. × 150 dias.

Annealing Principles.

The question of annealing temperatures has been the subject of much controversy among malleable ironfounders. It is a fact that both graphitisation and decarburisation proceed more rapidly the higher the temperature. It would therefore appear that for both white-heart and black-heart-type malleable a high annealing temperature would be advisable, both in economy of fuel and in time. There are, however, very serious objections to the use of very high temperatures. In the first place, it is not economical, since there is an excessive wear on the oven lining, and the annealing pans have a much shorter life. Also, the castings will warp very badly, and the packing material may frit on to the castings.

The quality of the material also suffers considerably. At high temperatures, excessive grain-growth occurs, and the graphite assumes a large and flaky form, instead of existing as small, rounded nodules. In practice, therefore, the annealing temperature must be balanced between speed and quality. The temperatures usually adopted in practice are from 860 to 880 deg. C. for black-heart-type malleable, and from 950 to 1,000 deg. C. for white-heart. The annealing period for black-heart malleable is from 60 to 80 hrs. at maximum temperature, and for white-heart from 100 to 120 hrs. is the usual period of anneal.

Mechanism of the Annealing Operation.

In considering the changes which take place in annealing malleable iron, it will be advisable to deal with black-heart type first. The unannealed hard iron consists entirely of pearlite and free cementite, the structure being more or less dendritic, as shown in Fig. 9. In the annealing operation this is heated as rapidly as is practicable to the maximum annealing temperature, that is, to about 880 deg. C. At this temperature, which is well above the A1 critical point, the structure is austenitic, with the excess of free cementite existing as a network around the austenite grains. By maintaining this temperature, carbon is precipitated from the austenite as free graphite, since graphite is the stable form of carbon in this range of alloys.

Fig. 14 shows the microstructure of a sample of hard iron which has been annealed at 880 deg. C. for a period of two hours and then drastically quenched-out in water. The quenching was not drastic enough to prevent the austenite decomposing to martensite, but the structure is, in other respects, identical to that in which the material existed prior to quenching. It will be seen that the austenite has absorbed free cementite up to its saturation limit, although the original dendritic structure has not yet been completely broken up. A little graphite has already been precipitated from the austenite, and can be detected as small dark nodules in the austenite grains.

As annealing continues, more carbon is precipitated from the austenite as free graphite, the nodules of which rapidly increase in size. As precipitation continues, the austenite absorbs free cementite to maintain its saturation, which is continually tending to be lowered by the precipitation of carbon.

Fig. 15 shows a further sample of the same original white iron which has been annealed at 880 deg. C. for 7 hrs., and then water-quenched. There is a conspicuous increase in the amount of free graphite, the nodules of which have grown considerably. The ground mass of austenite has now absorbed almost all of the free cementite, the residual traces of which are shown as a fine network around the crystal grains of austenite.

This continual precipitation of graphite and the corresponding absorption of cementite by the austenite continues, although the rate of transformation becomes distinctly slower as the material approaches the equilibrium condition. Annealing is continued until absolute equilibrium for that temperature is attained, that is, until the material consists entirely of saturated austenite and free graphitic carbon. Then, since the saturation limit of carbon in austenite is less with lower temperature, it will be necessary to cool the castings somewhat to precipitate more graphitic carbon from the austenite. The castings are, therefore, cooled slowly to the lowermost critical point, that is, to about 730 deg. C., graphitic carbon being progressively precipitated. At 730 deg. C. about 0.5 per cent. of carbon remains in solution in the austenite, and this is retained as pearlite in the finished castings if the temperature is dropped too rapidly at this stage.

Fig. 16 shows the microstructure of the centre of a piece of black-heart-type material which has been air-cooled from 730 deg. C. after passing through the normal annealing cycle up to that stage. It shows the considerable proportion of pearlite which is retained, due to the fast cooling, the structure, apart from the pearlite, being the normal one of graphite nodules in a matrix of ferrite. In practice, therefore, the castings are cooled slowly to a temperature well below the critical range, to ensure complete graphitisation.

Fig. 5 shows the microstructure of the centre of a piece of perfectly-annealed black-heart-type malleable. It consists of a matrix of ferrite grains, with nodules of graphitic carbon evenly distributed throughout the structure. It should be observed that there is not the slightest trace of pearlite remaining. Fig. 6 is typical of the edge of a piece of black-heart-type malleable. There is a very narrow band of completely decarburised iron, that is, of pure ferrite crystals, and then an extremely narrow band in which a little pearlite occurs, shading off into the normal structure. These two latter photographs are typical of good black-heart-type malleable iron, and exceedingly good physical tests would be given by a casting possessing such a structure.

White-heart Malleable.

In the case of white-heart malleable iron, the mechanism of the annealing process is quite different from that of the black-heart process. In this case the carbon has to be removed from the castings by oxidation. This is usually effected by packing the castings in an oxidising material such as red hematite ore, generally mixed with three times its bulk of old, used ore. After filling the muffle, it is raised to the annealing temperature, say, 960 deg. C., as rapidly as practicable. The structure of the castings then consists of saturated austenite and residual-free cementite. The action of the packing material

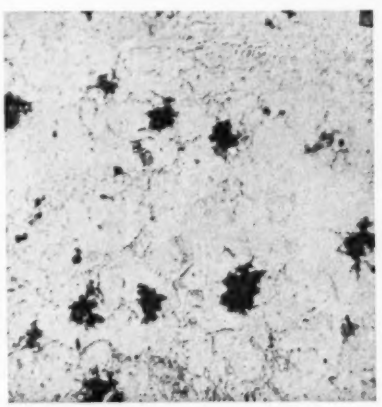

Fig. 15.—Blackeheart-type Iron Water-quenched after 7 hrs. Annealing at 880 deg. C. × 150 dias.

then is to remove carbon from the skin of the casing, according to the chemical reaction:—

$$3\ Fe_2O_3 + Fe_3C = 2\ Fe_3O_4 + CO_2 + 3\ Fe.$$

The carbon content of the austenite at the skin thus falls below the saturation point, and, as oxidation continues, free cementite is dissolved by the austenite to maintain its saturation. Soon there is no cementite left at the skin of the casting, and the austenite becomes poor in carbon content. A "concentration gradient" is thus set up between the centre and the skin of the casting, and carbon diffuses from the centre to the edge. This concentration gradient is maintained by the austenite at the centre absorbing the free cementite. The diffusion of carbon from the centre to the skin, where it is removed by oxidation, is then continuous.

When the free cementite has all been absorbed, diffusion and oxidation of the carbon continues, but more slowly, due to the levelling of the concentration gradient when the austenite becomes impoverished in carbon content. The effect of the high sulphur content is thus apparent, since it retards graphitisation, and allows most of the carbon to diffuse to the skin, where it is removed by oxidation. When sufficient carbon has been removed the muffle is allowed to cool to room temperature at a comparatively fast rate.

Fig. 4 shows the centre of a fully-annealed casting. In this sample the combined-carbon content is about 0.4 per cent., and should never

be higher than 0.7 per cent. in a good-quality white-heart casting. The structure consists of combined carbon, existing as pearlite, set in a matrix of ferrite, together with a little graphitic carbon. This structure should be uniform throughout the casting, except for a narrow band of pure ferrite at the skin of the casting. Considerable difficulty is always experienced when annealing a thick section of white-heart malleable iron, and some free cementite is often found at the centre of the casting. The high temperature and long period of anneal necessary to reduce the carbon content at the centre often results in a badly-oxidised skin, and "peeling" occurs. This "peeling" is almost as serious a defect as is the presence of free cementite at the centre.

"Picture-frame" Black-heart.

"Picture-frame" material consists of a normal black-heart core with a heavy pearlitic rim. Castings are made of this material when they are required to stand some abrasive wear, or if a high tensile strength is necessary. "Picture-frame" iron will not bend so well as black-heart-type malleable, nor will it give so good an elongation. It is, however, much superior to white-heart malleable iron in these respects, while its machinability is between that of black-heart-type malleable and white-heart. Fig. 12 shows a typical fracture of "picture-frame" material. It will be noted that the black-heart-type core, which consists entirely of ferrite and graphite, is identical with normal black-heart-type material, and the decarburised edge is quite conspicuous. Fig. 17 shows a photomicrograph of this edge. There is a narrow ferrite band on the extreme edge, and then a very heavy band of pearlite, with a little graphite appearing towards the centre. It then shades off into a normal black-heart-type core. It is this heavy pearlite band which gives it its increased tensile strength and wearing properties. While it is not to be recommended for the average run of castings, for certain purposes "picture-frame" material is preferable to either white-heart or black-heart-type malleable.

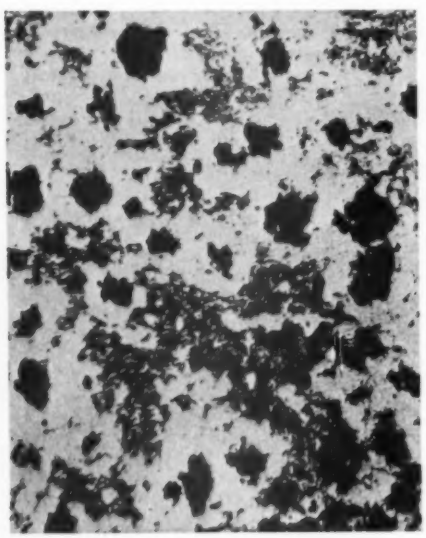

Fig. 16.—Black-heart-type Malleable Air-cooled from 730 deg. C. × 200 dias.

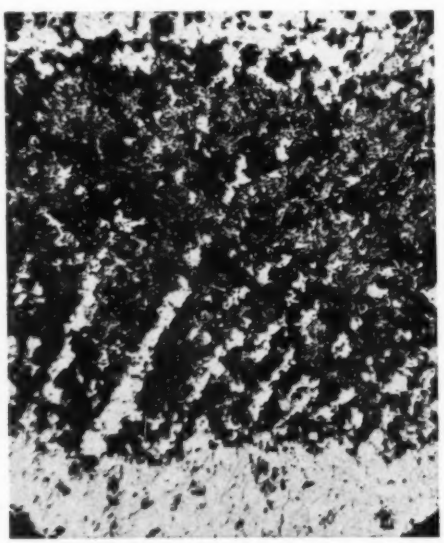

Fig. 17.—Heavy Pearlitic Rim of "Picture-frame" Material. × 150 dias.

Production of "Picture-frame" Material.

"Picture-frame" material is produced under identical annealing conditions as black-heart-type malleable, but the analysis of the hard iron used is somewhat different. The total carbon may be rather higher and the silicon a little lower, but these variations are very slight. The essential difference is in the manganese content, which is rather lower. So far as the authors are aware, no really adequate explanation has been put forward to explain this effect of the lower manganese content, but in the authors' opinions it functions as follows:—In the annealing of black-heart-type malleable, decarburisation of the skin always takes place to a small degree, but the diffusion of carbon from the centre of the casting is almost sufficient to make good the loss. This is proved by the extremely narrow band which is produced in black-heart-type castings.

With "picture-frame" material, however, the manganese content is lower, and manganese is an inhibitor of graphitisation. It may, therefore, be assumed that graphitisation proceeds at a faster rate, resulting in the austenitic solution being left much poorer in carbon content. Thus the rate of diffusion of carbon in this weak austenitic solution will not be sufficiently fast to balance the loss by oxidation at the skin of the casting. A rim of low carbon content will, therefore, be produced around the skin of the casting. Now graphite is only stable in an iron of this composition, when the carbon content exceeds 1.6 or 1.7 per cent., so that the carbon in the rim is retained in the combined form after annealing, producing a pearlite area under the skin of the casting.

While the authors have no experimental proof for this theory, they consider that it offers a sound metallurgical explanation of the function of the manganese content. "Picture-frame" material can also be produced by an excess of manganese over the normal content. In this case, the effect of the manganese is to retain a larger proportion of carbon in solution in the austenite. The concentration gradient thus set up by the slight loss, due to the oxidation at the skin, is, therefore, steeper than is usual in black-heart practice, and the carbon loss is greater. A broad band of low carbon content is thus produced at the skin in which the carbon content is so low as to fall within the range of alloys in which iron carbide is the stable form of carbon, resulting in a pearlite structure on cooling below the critical range.

From the figures given it will be recognised that black-heart-type malleable is much superior to white-heart in almost every respect, and could, in fact, replace mild-steel castings or forgings for many general engineering purposes. The malleable industry in this country has had to face very severe competition from steel castings and drop forgings, but, since its production has been placed on a scientific basis, its field of application in the engineering trades has been greatly extended. Its analysis and physical properties can be altered to serve many diverse needs. In moderate sections, it can be made much cheaper than steel castings, and it can be cast in forms impossible to produce with a drop forging. Also, the amorphous carbon in the black-heart variety acts as a cushion for compressive and battering shocks, preventing failure from crystallisation, and in this respect the material is superior to steel castings or drop forgings.

Physical Properties.

Before concluding, it would be advisable to compare the physical properties of first-quality black-heart-type and white-heart iron.

Test.	Black-heart type.	White-heart type.
Tensile	24 to 26 tons	20 to 26 tons.
Elongation on 2 in. ..	14 to 18 per cent.	5 to 8 per cent.
Bend test	About 180 deg.	45 to 90 deg. max.
Machinability	Very good	Fairly good.
Electric permeability..	,,	Poor.
Resistance to corrosion	,,	Very good.

Finally, the authors wish to thank Messrs. Shotton Brothers, Limited, Oldbury, for the experimental facilities they have provided, and for their kind assistance in compiling much of the data used.

Railway Revenue and Charges.

The Railway Rates Tribunal opened last week the annual review of railway revenue, a duty imposed upon them by section 59 of the Railways Act, 1921. Mr. F. Bruce Thomas, K.C., who appeared for the four amalgamated railway companies, said that the deficiency on the working in 1929 was:—London and North Eastern, £1,770,866; London Midland and Scottish, £3,269,572; Great Western, £162,423; Southern, £173,564. The Court had to determine whether the deficiency was due to lack of efficiency or economy in the management. The Railways Act, 1921, provided that if the deficiency was not due to lack of efficiency or economy in management, and if it was likely to continue, the Tribunal should make such modifications in all or any of the standard rates and such a corresponding general modification in the exceptional charges of the company as they might consider necessary to enable the company to earn the standard revenue. It was for the Tribunal to consider whether by a modification of charges it was possible to achieve that result. If, on the other hand, the Tribunal found that object could not be achieved by altering the charges, they would have to consider whether the Act imposed any duty upon them to make modifications which in their view would not enable the companies to attain their standard revenue. That was a question the Tribunal had faced last year when they had arrived at the conclusion that modification would not enable them to earn the standard revenue, and they had made no alterations. He assumed that the Tribunal would interpret the section in the same way this year. The opinion of the companies was that, in view of the present industrial and economic conditions of the country, it was doubtful if an increase in their charges would result in any material improvement in their financial position.

Contracts Open.

Bakewell, May 31.—Providing, laying and jointing about 7,800 yds. of 5-in., 4-in. and 3-in. cast-iron pipes, and the construction of a mass concrete service tank (capacity 150,000 galls.), etc., for the Bakewell Rural District Council. Messrs. Brady & Partington, Market Street, Chapel-en-le-Frith. (Fee £5, returnable.)

Dundee, June 12.—Supply and laying of 655 ft. of 42-in. dia. cast-iron spigot and faucet piping, for the Town Council. Mr. D. H. Bishop, general manager and engineer, Dudhope Crescent Road, Dundee. (Fee £2 2s., returnable.)

Wallingford, June 2.—150 tons of 3-in. and 2-in. spigot and socket cast-iron pipes, for the Rural District Council. Messrs. Fiddian & Deeley, 13, Church Street, Stourbridge.

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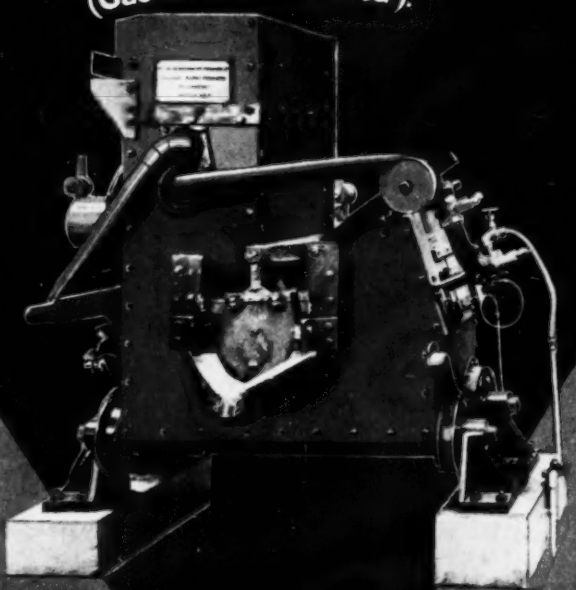

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Submerged Combustion.

A new advance in the use of fuel is submerged combustion, now definitely a successful commercial proposition, is well indicated by the recent Paper in London before the Institute of Fuel by C. Featherstone Hammond. One particularly interesting application, for example, is the melting of white metals, and many other important possibilities are represented in connection with the casting of bronze, gunmetal, and many different alloys.

In order to burn a flame continuously beneath the surface of cold water or other liquid, such as

Fig. 1.—The "Hammond" Burner.

molten metal, using either gaseous, liquid, or pulverised solid fuel, an enormous rate of heat emission is necessary to prevent the flame from being cooled and extinguished, while proper mixing of the fuel and the air and the elimination of the danger of the flame striking back are also essential.

The "Hammond" burner is claimed, after a number of years' detailed research work, to have solved these problems, and the complete equipment, as supplied by Submerged Combustion, Limited, of London, is certainly of the most ingenious character. In the case of towns' gas, for example, the exact theoretical amount of air and gas for complete combustion is supplied to the burner under pressure, a London town's gas of 500 B.T.U. per cub. ft. requiring 4.7 volumes of air and 1.0 volume of gas, each at 5 lbs. pressure, as given by the use of a small electric-driven duplex booster in the circuit, which delivers the gas and the air separately to the proportioning valve, capable of very accurate adjustment.

The burner is fixed below the surface of the liquid being heated, and is lined with the refractory material known as Alundel, while the rate of combustion is so enormous that about 20,000,000 B.T.U. are given out per hour for every cubic foot of combustion space, several hundred times the rate of ordinary solid fuel and forced-draft firing. The flame burns quite easily under molten metals, water, solutions in water, oils, and other liquids, and highly important also is the evaporation of different liquids such as sulphuric acid and phosphoric acid.

As regards the melting of lead, solder, tin, antimony, silver, type metal, and other white metals, as typical the "Hammond" white-metal-melting machine, size "0," takes 0.6 therm (60,000 B.T.U.) of gas per hour, and weighs empty 1,555 lbs. The capacity is 700 lbs. of lead and the throughput 1,100 lbs. of lead per hr. pouring at 400 deg. C., with slightly different figures for the other metals, the arrangement including a gas-fired surface combustion tile for preliminary heating, while the efficiency is extremely high, over 95 per cent., as would be expected with the flame actually in the liquid.

Core-Shop Efficiency.

Following Mr. F. Hudson's useful contribution to this subject (printed in our May 15 issue), there were several points of outstanding interest brought out in the subsequent discussion, such as the utility of emulsification, the non-elimination of iron oxide by winnowing and the use of sodium silicate.

Emulsification of Oil and Water.

In the course of the discussion, Mr. F. J. Cook called attention to the omission from the Paper of any reference to the emulsifying of oil and water, and asked if Mr. Hudson recommended that practice. If so, what kind of oil did he recommend and what was the correct percentage of water? Mr. Cook added that the drying of oil-sand cores was as much a question of oxidation as temperature, and said he would like to know whether Mr. Hudson had any data as to the drying effect of different quantities of air going into the stove. With regard to sodium silicate, he had never heard of its use as applied to cores, and he would be interested to have details, as the use of sodium silicate seemed to have possibilities for the hardening of cores.

Use of Sodium Silicate.

In reply, Mr. Hudson confessed that he was not in favour of the emulsification of oil and water. In the first place, the product after emulsification was thicker than straight oil and more difficult to mix. Secondly, in order to get a proper emulsion, it was not sufficient to mix the constituents or blow air through them. It was necessary to have a special emulsifying machine. Even with the use of a proper machine, in no case had the results of tests that he had done been equal to those obtained from straight linseed oil. They could get a permanent emulsion in practically any oil and water percentage provided that a third material was added to stabilise the product. As to drying and the amount of oxygen supplied to cores as affecting the results obtained, they were at the present time studying the question, but the results were not ready in time to be embodied in the Paper. They had modified their core stove in order to control the air going in very definitely, and hoped shortly to have some information on the point. With respect to the use of sodium silicate for protecting cores, sodium silicate must be applied to the baked core. If it was applied to a core in the green state, it would destroy the bond. It saponified the oil. A proportion of 10 per cent. of sodium silicate with water was quite enough to cause a very hard skin to form. On top of the sodium silicate it was advisable to put a coating of blackwash. If that was not done, the sodium silicate was apt to fuse to the metal, causing softening of the sand, and they might get what appeared like a scab.

Iron Oxide and Sand Reclamation.

Mr. D. Wilkinson said he preferred a stove to work under a slight pressure and not to have a free draft through it. It was wonderful what an amount of draft they got from the natural cracks and crevices in the stove. The lecturer had mentioned the reclaiming of sand in the foundry, but there was one great difficulty. The temperature of the molten metal caused a considerable amount of dust in the sand. Even if they winnowed the sand there was still a fair amount of very thin oxide of iron. Unless they were able to get rid of this they induced a considerable amount of fusibility. He wondered if the lecturer had any experience of how to get rid of the oxide of iron. Sand in Great Britain was comparatively cheap, and it was a question whether it was economical to reclaim sand rather than obtaining new sand. But supposing there was no economy, it was a great deal less trouble to reclaim sand than to be continually having new sand coming in that might vary considerably in quality. With regard to drying stoves, it seemed to him that the stove of the future would be of a continuous character and probably a vertical one. Although it might be playing for safety, he preferred to vent every core that went into the mould.

Splitting of Sand Grains.

Replying, Mr. Hudson said that so far as the reclamation of sand was concerned, he was not convinced that sand split up on heating.

Mr. Wilkinson: Put it under a microscope. I am convinced.

Mr. Hudson, proceeding, said he would prefer to have some definite figures. It was in America that reclamation had been practised and where more work had been done on reclaiming sand than in any other country in the world. He had studied such information as was available, and he could get no definite experimental evidence that sand did split up. On the other hand, he could get definite evidence that no splitting up took place. He thought the probability was that some sands split up and others did not. As to the presence of oxide of iron, that was something new to him. With the exception of those in immediate contact with the casting, he could not see how the sand grains became coated with oxide of iron, and the reclamation of sand only applied to the burnt cores, which had not been in contact with the metal. His idea of a good reclaiming plant was some type of crushing-mill in association with a special type of screen or air classifier. With reference to sodium silicate, it might be thought that it would have some effect on refractoriness. He did not think, however, that in the proportion of 10 per cent. much trouble would be experienced, though the precaution was taken of using blackwash. Sodium silicate was very hygroscopic, and to destroy that they had to heat it up to about 535 deg. C., which, of course, burnt the core. The use of sodium silicate demanded that the core should be cast early. They had to coat it just before casting and get the box closed as soon as possible, and that was not always convenient. As to travelling core stoves, he thought Mr. Wilkinson was looking rather more than twenty years ahead. While he (Mr. Hudson) appreciated that travelling stoves were highly successful for the lighter classes of work, there was very grave doubt whether they would be of any benefit to foundries producing heavy castings. He admitted that venting was a safeguard; on the other hand, he was convinced it was unnecessary, provided they knew their sands and knew something about their binder.

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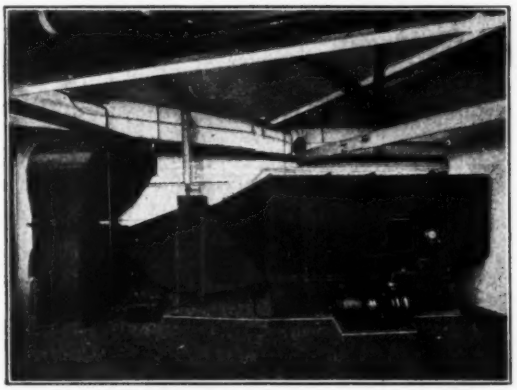

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Trade Talk.

An order has been received by Messrs. Smith's Dock Company, Limited, Middlesbrough, for nine whaling vessels for a Norwegian syndicate.

Messrs. Workman Clark (1928), Limited, of Belfast, have booked an order for a second floating whale oil factory for Norwegian owners.

Messrs. Dorman, Long & Company, Limited, Middlesbrough, have secured an order for 13,500 tons of steel rails and fishplates for the Union of South Africa.

The Park Gate Iron & Steel Company, Limited, Rotherham, produced during the year ended March 31 last, 179,990 tons of steel ingots, the highest total so far recorded.

Messrs. Darby & Company, of Navigation Street, Birmingham, advise us that they have opened a department dealing with all kinds of repetition turned work and light pressings in all metals.

Messrs. James A. Silver, Limited, Roseneath, have received an order for a twin-screw cruiser, for delivery in April, 1931. This is the first order placed on the Clyde for a yacht for next year's delivery.

The English Steel Corporation, Limited, has obtained an order for 500 tons of equipment for a fixed nitrogen plant in British Columbia. The order has been secured from the Consolidated Mining & Smelting Company in competition with United States and Continental firms.

The employees of Messrs. G. & J. Weir, Limited, Cathcart, Glasgow, have contributed the sum of £500 from their Infirmaries Fund for the half-year to various charitable institutions, whilst those of the Ardrossan Dockyard Company, Limited, have sent the sum of £160 during the past twelve months.

Messrs. George Brown & Company, Limited, Greenock, launched the motor salvage vessel "Traverse," which they have built to the order of the Quebec Salvage & Wrecking Company of Canada. The vessel is 130 ft. long and of 400 tons gross. She is propelled by a Worthington-Simpson Diesel engine, and fitted with a six-barrel steam-winch and 10-ton cranes for salvage work.

The shareholders of Mesrs. John Brown & Company, Limited, and Messrs. Thomas Firth & Sons, Limited, the Sheffield steel manufacturers, will shortly be called together to consider a scheme of amalgamation. The two companies have worked in close co-operation for some years, Messrs. John Brown & Company holding a majority of the ordinary share capital of Messrs. Thomas Firth & Sons.

An important step in the development of the railway system of Nyasaland, involving the building of a bridge over the Zambesi and the extension of the existing lines, is announced. The capital required will be provided by the Nyasaland Government. Under the scheme proposed, which provides for the formation of a new company, the existing systems will be linked up in an unbroken route between Lake Nyasa and the Port of Beira.

Mr. Ronald Wild, Vice-President of the Rustless Iron Corporation of America, Baltimore, Maryland, points out that an error of description crept in with regard to the photograph which we reproduced in our May 1 issue. The application of the straight chrome rustless iron was for hub caps, and these were shown in the photograph as being unloaded by means of an electro-magnet at the plant of the Rustless Iron Corporation of America.

The Standing Committee appointed by the Board of Trade will hold an inquiry at 11.30 a.m. on Monday, July 7, and at 10.30 a.m. on Tuesday, July 8, as to whether imported motor-cars, lorries, trucks and other motor vehicles, internal-combustion engines of all descriptions, chassis units, etc., should be required to bear an indication of origin. The inquiry will be held at the Board of Trade offices, Great George Street, London, S.W.1.

The Federation of British Industries has set up a committee to consider the possible reactions upon industry of the Consumers' Council Bill now before the House of Commons and the Committee on Restraint of Trade, which has been set up by the Lord Chancellor and President of the Board of Trade. The committee will include representatives of about 27 industries, including engineering, the coal industry, cement making and light castings.

Owing to the continued expansion of their business, the licensees of Messrs. Wild-Barfield Electric Furnaces, Limited, Elecfurn Works, North Road, Holloway, London, N.7, for France, Switzerland and the Netherlands, La Compagnie Française "Wild-Barfield" have recently taken extensive new premises at 110, Avenue du Général Michel Bizot, Paris. A full range of Wild-Barfield electric furnaces will be manufactured and sold from these works.

The management of the Carron Company have, during the past three weeks, had the pleasure of welcoming the representatives of several industries and technical societies on tours of inspection of the ironworks, foundries and collieries. These include the East of Scotland Mining Electrical Engineers and the Scottish Geological Society. On May 17 a party of over 100 students and staff of the Royal Technical College, Glasgow, visited the works. In each case the hospitality of the company included tea and refreshments served in the Welfare Club at the Mungal foundry.

In London on May 23, in conjunction with British Brown-Boveri, Limited, Messrs. A. Reyrolle & Company, Limited, Hebburn-on-Tyne, gave a film exhibition illustrating switchgear construction and operation. The Brown-Boveri film showed in a remarkably clear way the various phenomena which occur not only when a circuit-breaker has to break current, but also when it has to make and carry momentarily a heavy short circuit. The Reyrolle film demonstrated the manufacture, testing and installation of switchgear of the metal-clad type, which had been designed as a practical application of the results of research similar to that just indicated.

According to a cablegram from Johannesburg, twelve tenders have been submitted by British and German firms for the construction of three of the most important sections of the proposed State-controlled steelworks at Pretoria. There are no American tenders, but American firms are indirectly interested, as the German firms who submitted tenders are licensed to construct American-designed plant. It is expected that the orders will be placed within the next three months, and the final decision will be taken in London, although it will be subject to confirmation in South Africa. Dr. van der Byl, chairman of the South African Iron & Steel Industrial Corporation, is leaving for Europe immediately in order to negotiate the contracts.

Trials have been satisfactorily completed on the Firth of Clyde by the steamer "Carron," belonging to the Carron Company, Falkirk, after extensive overhaul by Messrs. William Beardmore & Company, Limited, Dalmuir. The Carron Company, which was founded about the middle of the eighteenth century, at a time when conveyance of heavy goods by road was surrounded by many difficulties and rail transport not introduced, began their shipping service between the Firth of Forth and London, since when they have maintained an unbroken sea connection. Their first vessel, named "Carron," was a sloop in 1777. There have been five steamers named "Carron" since 1851, and the fourth rendered service during the war as an auxiliary unit of the Royal Navy.

The first steel foundry to be established in Egypt, at the Port Said Engineering Works, is now being equipped. The plant and materials are all going out from this country, and the contract for the supply of the whole of them was placed in the hands of the Sheffield firm of Beecroft & Partners, Limited, Retort Works, Mappin Street. Messrs. Beecroft have supplied a steel-melting furnace, manufactured by British Furnaces, Limited, Chesterfield, and cupola and ladles from the Constructional Engineering Company, Birmingham. The output capacity of the foundry will be 30 tons of castings per week. Mr. G. C. Castle and Mr. Beecroft are now on their way to Egypt to superintend the erection of the plant and the production of castings from the furnace.

Moulding and Casting.

(*Continued from page* 398.)

shape, as it does not entirely prevent the metal from flowing over at E, and at a time when everyone concerned should be calm and collected, and it is likely to cause excitement and confusion. F is quite a good type of runner basin, especially for work which has to be machined all over, the dirt trap shown is also a good means of trapping any sullage or dirt that may get through the neck of the down-runner. G is the type of runner usually adopted when the casting is not to be machined, unless the runner basin is not solely depended upon for producing clean castings. This is used in cases where a sullage runner is placed upon the joint of the mould.

Personal.

Mr. Bernard D. F. Docker has been elected a director of Messrs. James Booth & Company (1915), Limited, and Messrs. John Wilkes, Sons & Mapplebeck, Limited, metal manufacturers.

Mr. Charles M. Schwab, chairman of the Bethlehem Steel Corporation and President of the American Iron and Steel Institute, has been awarded the Gary memorial medal for outstanding service in the steel industry during the last year.

Mr. Ernest Haigh, who has just retired from the position of works engineer at the Britannia Steelworks of Messrs. Dorman, Long & Company, Limited, Middlesbrough, was the recipient of a presentation from the officials and staff of the works as a mark of esteem.

The Hon. Roland Kitson, who was made President-Elect of the National Federation of Iron and Steel Manufacturers at the recent annual meeting, is the younger son of the late Lord Airedale and brother of the present peer. He was born at

The Hon. Roland Kitson, D.S.O., M.C.

Leeds in 1882, and was educated at Westminster School and Trinity College, Cambridge. After leaving the University he entered the workshops of Messrs. Kitson & Company, Leeds, and passed through the various departments, after which he entered the works of the Monk Bridge Iron & Steel Company, and served in the various administrative and business departments of that firm. For some years Mr. Kitson was on the board of Messrs. Bolckow, Vaughan & Company, Limited, Middlesbrough, and for four years was chairman of the company. He played an important part in the negotiations which finally led to the amalgamation with Messrs. Dorman, Long & Company, Limited. Mr. Kitson served with the 8th West Yorkshire Regiment during the war, attaining the rank of brigade major. He was twice mentioned in despatches, and received the Military Cross and Distinguished Service Order. In addition to his iron and steel interests, Mr. Kitson is a director of the Ford Motor Company in this country, France and Holland, and is also a director of the Bank of England. He is a Justice of the Peace for the West Riding of Yorkshire, a Deputy Lieutenant of the City of London, and a member of the Council of the Iron and Steel Institute.

Wills.

Field, M. B., of Glasgow, managing director of Messrs. Kelvin, Bottomley & Baird, Limited	£10,925
Foster, Joseph, of Messrs. Foster Brothers & Company, structural engineers, Preston	£24,525

Obituary.

Mr. J. C. Gray, chairman of Messrs. Kirkpatrick, Limited, malleable ironfounders, of Walsall, died recently.

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Iron and Steel Markets.

Pig-Iron.

MIDDLESBROUGH.—Current business in the Cleveland iron market affords little indication of early improvement. There is little interest being taken. Buying is only to meet more immediate needs, while consumers, with few exceptions, confine purchases to very moderate quantities. This qualification applies with equal force to both home and export transactions, with the result that market operations are reduced to very small proportions. The Cleveland ironmasters do not attempt to disguise the fact that trade is disappointingly slow. But they are determined to regulate output according to the actual requirements of industry, and if these latter show a further contraction, then it is certain that more blast furnaces will go out of action. Perhaps, the one hopeful feature in the existing position is the relatively small import of iron from the Continent. European competition is not a serious factor in the home market, but Indian pig-iron is still coming into Scotland, and it is cutting severely into the Cleveland iron trade in that area. In the conditions thus outlined quotations remain at the fixed minimum levels, as follow:—No. 1 Cleveland foundry iron, 70s.; No. 3 Cleveland G.M.B., 67s. 6d.; No. 4 foundry, 66s. 6d.; No. 4 forge, 66s. per ton.

Since the reduction of output, recently reported in the North-East Coast hematite industry, the market has steadied down to some extent, and prices are fairly well maintained, the quotation for mixed numbers now ruling at 74s., with 6d. per ton extra for No. 1 quality. On the North-West Coast Bessemer mixed numbers have declined to 72s. to 73s. per ton at works.

LANCASHIRE.—Consumers of foundry pig in this area are still contented with the hand-to-mouth policy of buying, and until industrial conditions in Lancashire improve appreciably compared with the present position, there is not likely to be much improvement in the rate at which pig-iron is being bought. No alteration has yet been made in quotations, current prices remaining as previously, with Derbyshire and Staffordshire No. 3 qualities on offer at 77s. and No. 3 Scotch brands 95s., all per ton delivered local stations.

THE MIDLANDS.—Following the general rule, consumers of foundry pig in the Black Country area will purchase only small supplies to cover immediate needs. In no circumstances will they commit themselves to forward supplies at present price levels, as they are of opinion that current figures are too high and that if they hold out lower prices will obtain. All the furnaces are eagerly competing for fresh business at current prices, which are 75s. for Northants No. 3 and 78s. 6d. for Derbyshire and North Staffordshire No. 3, with Scotch qualities at about 94s., all per ton delivered stations in the Birmingham and the Black Country.

SCOTLAND.—In the Scottish market the demand for foundry iron continues on a very restricted scale, but the makers still hold to their fixed price of 78s. for No. 3 f.o.t. furnaces. The foundries are mostly working short time, and their consumption is correspondingly reduced. They consequently are very little interested in buying of any grade of iron at the moment.

Finished Iron.

At Birmingham, apart from the moderately good demand for Staffordshire marked bars, there is no satisfactory feature to report. Marked bars are quoted at £12 10s. at works, and the makers have their mills fairly well occupied at this juncture. There is keen competition for the available business from consumers and stock merchants for crown bars. An average price from Staffordshire would be £10 5s. per ton, but crown bars from other districts are to be obtained at £10 per ton. The local price for nut and bolt iron is £9 to £9 7s. 6d., but little support is forthcoming at this level, as the bulk of the available business is going to the French or Belgian works, whose price is still under £6 per ton delivered Black Country works.

Steel.

Although to a great extent still under the influence of general trade depression, business in the markets for British steel continues moderately active in supplying home needs, chiefly in the replenishment of merchant stocks. At Sheffield the demand for Siemens acid billets has relapsed to the small proportions of six months ago, but buying of basic billets has not further contracted; in fact, for soft qualities there appears to be a slight improvement. Business in wire rods is poor. Prices, which are unchanged, are:—Siemens acid billets, £9 10s.; basic billets, soft, £6 10s.; medium, £7 12s. 6d.; hard, £8 2s. 6d. to £9 12s. 6d.; wire rods, acid, £12 5s. to £12 10s.; basic, soft, £8; medium hard, £9 15s. to £10; hard. £10 10s. to £11. The tinplate market is quiet, with the quotation unchanged at 18s. 3d. to 18s. 6d., coke quality, net cash, f.o.b. Welsh ports.

Scrap.

Markets for this class of foundry material continue lifeless, consumers in general only buying in sufficient quantities to meet immediate needs. At Middlesbrough heavy cast iron is the strongest section, but even here prices have eased slightly, and buyers can now obtain ordinary quality at 59s. per ton and good machinery quality at 62s. In Yorkshire heavy cast iron attracts little attention, but the price is maintained at 57s. 6d. for ordinary and 60s. for machinery quality, both delivered. In Scotland business is still on a restricted scale, with machinery cast iron suitable for foundries quoted at 67s. 6d. to 68s. 6d., ordinary heavy cast iron 62s. 6d. to 63s. 6d., and light cast-iron scrap 52s. to 54s., with firebars at 52s. 6d. The above prices are all per ton delivered f.o.t. consumers' works.

Metals.

Copper.—Disappointment with the statistical position was marked by a further relapse of warrant copper values last week, while, as far as buying by consumers is concerned, the market is likely to be quiet for some time ahead. Users covered themselves at the low prices ruling a fortnight ago, and in view of the action of Copper Exporters, Inc., in raising its price again to the higher level of 13c., are likely to run their stocks down to a low level before again placing substantial orders.

Closing quotations :—

Cash.—Thursday, £54 7s. 6d. to £54 12s. 6d.; Friday, £54 to £54 5s.; Monday, £54 5s. to £54 7s. 6d.; Tuesday, £53 17s. 6d. to £54 2s. 6d.; Wednesday, £53 15s. to £53 17s. 6d.

Three Months.—Thursday, £54 7s. 6d. to £54 10s.; Friday, £54 to £54 5s.; Monday, £54 2s. 6d. to £54 5s.; Tuesday, £53 17s. 6d. to £54 2s. 6d.; Wednesday, £53 15s. to £53 17s. 6d.

Tin.—The recovery in values recently noted in standard cash tin met with a further reverse during the past week, closing considerably lower. Without doubt, the statistical position is still unfavourable, in spite of the efforts that have been made to restrict production and thus stabilise market conditions. Hidden stocks, always a feature to be reckoned with in this market, seem again to have upset calculations.

Official closing prices :—

Cash.—Thursday, £142 10s. to £142 12s. 6d.; Friday, £141 to £141 2s. 6d.; Monday, £141 17s. 6d. to £142; Tuesday, £143 5s. to £143 7s. 6d.; Wednesday, £141 2s. 6d. to £141 5s.

Three Months. — Thursday, £144 10s. to £144 12s. 6d.; Friday, £143 to £143 2s. 6d.; Monday, £143 17s. 6d. to £144; Tuesday, £145 5s. to £145 7s. 6d.; Wednesday, £143 2s. 6d. to £143 5s.

Spelter.—Although spelter values improved slightly in the course of last week, it cannot be said that the intrinsic position of the metal has undergone any great change for the better. The consuming trades generally are not busy, and any further increase in price will only serve to discourage purchases on a more extensive scale.

Daily fluctuations :—

Ordinary.—Thursday, £16 17s. 6d.; Friday, £16 17s. 6d.; Monday, £16 15s.; Tuesday, £16 18s. 9d.; Wednesday, £16 16s. 3d.

Lead.—Prices of soft foreign pig have also improved slightly in this market, but the aggregate amount of business has not been large and conditions show little real change.

The week's prices have been :—

Soft Foreign (Prompt).—Thursday, £17 17s. 6d.; Friday, £17 18s. 9d.; Monday, £18 2s. 6d.; Tuesday, £18; Wednesday, £18.

Students' Corner.

Q.—Are special materials required for making metal moulds?

A.—The material for these moulds is important. A good-quality cast iron up to the present has been found the most useful. It must be free from all openness or porosity, must be dense, and neither too hard nor too soft. If hard, it is difficult for the mould fitter. If soft, it is easily penetrated by metal when continually pouring. Probably the most satisfactory metal for the moulds is when the pieces required are poured into permanent moulds. Of course, any plugs used for drawing purposes are usually steel.

Q.—Is there any kind of protective dressing for the moulds when in use?

A.—There are some, but are not very effective; if the castings stick in the moulds from over-heating, the best cure is to give the mould a rest.

Q.—What is the difference between a permanent mould and a die (so-called) mould?

A.—There is no difference, though usually die castings are non-ferrous, and there are three or more ways of pouring: (1) gravity pouring; (2) head pressure; and (3) plunger, or air pressure. Permanent moulds for cast iron are gravity poured.

Q.—When designing a permanent mould, are there any special points to consider?

A.—The chief factor is simplicity of design.

Q.—How can a permanent mould be vented?

A.—At the joints. This is often necessary owing to the air being confined in the mould; it is compressed when being poured, and prevents the fluid metal flushing up corners and feather-edge places. If the air cannot pass through the joints of the mould, special provision must be made for its escape.

Q.—What is meant by the term solid contraction?

A.—After the period of liquid solidification is passed, solid contraction commences and continues until the metal is cold.

Q.—Do all metals contract alike?

A.—Various metals may have various contractions. Steel, aluminium and other metals may contract more than cast iron, and some other alloys less than cast iron.

Good Quality Brass can be obtained with a mixture of copper 88, tin 9.5, and zinc 2.5 per cent. The resultant mixture will wear well, and is ideal for bearings, besides being quite reasonable in cost.

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SOLID RIBBED ROLLED STEEL
MOULDING BOXES

are recognised as standard box equipment by the leading foundries and engineering establishments in this country and overseas.

Because they speed up production, save unnecessary labour, produce accurate castings and make for all-round efficiency in the foundry.

STERLING BOXES WILL SAVE THEIR COST IN A FEW MONTHS.

WRITE FOR CATALOGUE No. 37.

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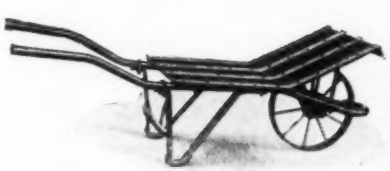
for

SAND, COKE, and PIG-IRON

are sturdily built to withstand the heavy duties and harsh treatment of the severest foundry service.



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WEEKLY PRICE CURRENT.

COPPER.

	£	s.	d.
Standard cash	53	15	0
Three months	53	15	0
Electrolytic	60	10	0
Tough	59	10	0
Best selected	60	0	0
Sheets	87	0	0
India	72	0	0
Wire bars	61	7	6
Do. June	61	7	6
Do. July	61	7	6
Ingot bars	61	7	6
H.C. wire rods	63	12	6
Off. av. cash, April	62	3	3¾
Do., 3 mths., April	61	4	10½
Do., Sttlmnt., April	62	3	7½
Do., Electro, April	75	1	0
Do., B.S., April	68	10	3½
Do., wire bars, April	75	15	3
Aver. spot price, copper, Apr.	62	3	3¾
Solid drawn tubes			12½d.
Brazed tubes			12½d.
Wire			8½d.

BRASS.

Solid drawn tubes	11d.
Brazed tubes	12½d.
Rods, drawn	10½d.
Rods, extd. or rlld.	6½d.
Sheets to 10 w.g.	9½d.
Wire	9½d.
Rolled metal	8¾d.
Yellow metal rods	6½d.
Do. 4 × 4 Squares	7½d.
Do. 4 × 3 Sheets	7½d.

TIN.

	£	s.	d.
Standard cash	141	2	6
Three months	143	2	6
English	142	0	0
Bars	144	5	0
Straits	143	5	0
Australian	142	10	0
Eastern	145	2	6
Banca	147	5	0
Off. av. cash, April	162	14	7½
Do., 3 mths., April	164	15	2½
Do., Sttlmt., April	162	14	9
Aver. spot, April	162	14	7½

SPELTER.

	£	s.	d.
Ordinary	16	16	3
Remelted	16	0	0
Hard	14	5	0
Electro 99.9	19	7	6
English	17	5	0
India	15	10	0
Zinc dust	23	0	0
Zinc ashes	4	15	0
Off. aver., April	18	1	11½
Aver., spot, April	17	16	4½

LEAD.

	£	s.	d.
Soft foreign ppt.	18	0	0
English	19	10	0
Off. average, April	18	6	9¼
Average spot, April	18	6	4½

ZINC SHEETS, &c.

	£	s.	d.
Zinc sheets, English	27	0	0
Do. V.M. ex-whf.	25	15	0
Rods	30	0	0
Boiler plates	24	0	0
Battery plates	24	10	0

ANTIMONY.

	£	s.	d.
Special brands, Eng.	40	0	0
Chinese	27	5	0
Crude	20	0	0

QUICKSILVER.

	£	s.	d.
Quicksilver	22	10	0

FERRO-ALLOYS AND STEEL-MAKING METALS.

	£	s.	d.
Ferro-silicon—			
25%	7	17	6
45/50%	11	10	0
75%	18	10	0
Ferro-vanadium—			
35/50%	12/9 lb. Va.		
Ferro-molybdenum—			
70/75% c. free	4/2 lb. Mo.		
Ferro-titanium—			
23/25% carbon-free	9d. lb.		
Ferro-phosphorus, 20/25%	£16	0	0
Ferro-tungsten—			
80/85%	2/10 lb.		
Tungsten metal powder—			
98/99%	3/1 lb.		
Ferro-chrome—			
2/4% car.	£30	10	0
4/6% car.	£23	7	6
6/8% car.	£22	10	0
8/10% car.	£22	0	0
Ferro-chrome—			
Max. 2% car.	£33	15	0
Max. 1% car.	£37	17	6
Max. 0.70% car.	£39	10	0
70% carbon-free	11d. lb.		
Nickel—99% cubes, or pellets	£175	0	0
Ferro-cobalt	9/7 lb.		
Aluminium 98/99%	£95	0	0
Metallic chromium—			
96/98%	2/7 lb.		
Ferro-manganese (net)—			
76/80% loose	£11	15	0
76/80% packed	£12	15	0
76/80% export	£11	10	0
Metallic manganese—			
94/96% carbonless	1/4 lb.		

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten	£0 2 2
Finished bars, 18% tungsten	£0 3 0

Per lb. net, d/d buyers' works.

Extras—

Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to $\frac{1}{16}$ in.	1/– lb.
Flats, ½ in. × ¼ in. to under 1 in. × ¾ in.	3d. lb.
Do., under ½ in. × ¼ in.	1/– lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

SCRAP.

	£	s.	d.		£	s.	d.
South Wales—							
Heavy steel					3	0	0
Bundled steel and shrngs.	2	15	0	to	2	18	0
Mixed iron and steel					2	15	0
Heavy cast iron	2	17	0	to	2	18	0
Good machinery for foundries	2	17	6	to	2	19	0
Cleveland—							
Heavy steel					2	12	6
Steel turnings					2	8	0
Cast-iron borings					2	2	6
Heavy forge					3	10	0
W.I. piling scrap					3	7	6
Cast-iron scrap	2	19	0	to	3	2	0
Midlands—							
Ord. cast-iron scrap					3	2	6
Heavy wrought	3	7	6	to	3	10	0
Steel turnings	1	12	6	to	1	15	0
Scotland—							
Heavy steel					2	15	0
Cast-iron borings					2	8	0
Wrought-iron piling					3	18	0
Heavy machinery					3	7	6

London—Merchants' buying prices delivered yard.

	£	s.	d.
Copper (clean)	47	0	0
Brass	35	0	0
Lead (less usual draft)	15	10	0
Tea lead	11	10	0
Zinc	9	0	0
New aluminium cuttings	60	0	0
Braziery copper	44	0	0
Gunmetal	44	0	0
Hollow pewter	110	0	0
Shaped black pewter	82	0	0

PIG-IRON.

(f.o.t. unless otherwise stated.)

N.E. Coast—	
Foundry No. 1	70/–
Foundry No. 3	67/6
Foundry No. 4	66/6
Forge No. 4	66/–
Hematite No. 1	74/6
Hematite M/Nos.	74/–
N.W. Coast—	
Hem. M/Nos. d/d Glas.	85/6
„ d/d Birm.	93/6
Midlands—	
Staffs. common*	—
„ No. 4 forge*	73/6
„ No. 3 fdry.*	78/6
Shrops. basic	—
„ Cold blast, ord.	—
„ „ roll iron	—
Northants forge*	70/–
„ fdry. No. 3*	75/–
Derbyshire forge*	73/6
„ fdry. No. 3*	78/6
„ basic*	—
*d/d Black Country dist.	
Scotland—	
Foundry No. 1	80/6
„ No. 3	78/–
Hem. M/Nos.	81/–
Sheffield (d/d district)—	
Derby forge	68/6
„ fdry. No. 3	73/6
Lincs. forge	70/–
„ fdry. No. 3	75/–
E.C. hematite	89/–
W.C. hematite	90/–
Lincs. (at furnaces)—	
Forge No. 4	—
Foundry No. 3	—
Basic	—
Lancashire (d/d eq. Man.)—	
Derby forge	72/–
„ fdry. No. 3	77/–
Staffs foundry No. 3	77/–
Dalzell, No. 3 (special)	105/– to 107/6
Summerlee, No. 3	95/–
Glengarnock, No. 3	—
Gartsherrie, No. 3	95/–
Monkland, No. 3	95/–
Shotts, No. 3	95/–

FINISHED IRON AND STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

Iron—	£	s.	d.		£	s.	d.
Bars (cr.)					10	15	0
Nut and bolt iron	9	0	0	to	9	7	6
Hoops					10	15	0
Marked bars (Staffs) f.o.t.					12	10	0
Gas strip					10	15	0
Bolts and nuts, ¾ in. × 4 in.					15	5	0
Steel—							
Ship plates	8	15	0	to	8	17	6
Boiler plts.	9	17	6	to	10	10	0
Chequer plts.					10	12	6
Angles					8	7	6
Tees					9	7	6
Joists					8	10	0
Rounds and squares, 3 in. to 5½ in.					9	7	6
Rounds under 3 in. to ¾ in. (Untested)					8	2	6

and upwards

Flats—8 in. wide and over	8 12 6
„ under 8 in. and over 5 in.	8 17 6
Rails, heavy	8 10 0
Fishplates	12 0 0
Hoops (Staffs)	9 5 0 to 9 15 0
Black sheets, 24 g.	9 15 0
Galv.cor.shts., 24g.	11 17 6
Galv. fencing wire, 8g. plain	12 0 0
Billets, soft	6 0 0 to 6 10 0
Billets, hard	7 10 0 to 8 0 0
Sheet bars	5 15 0 to 6 5 0
Tin bars	6 2 6 to 6 5 0

PHOSPHOR BRONZE.

	Per lb. basis.
Strip	1/1½
Sheet to 10 w.g.	1/2
Wire	1/3½
Rods	1/2½
Tubes	1/6½
Castings	1/1½

Delivery 3 cwt. free.
10% phos. cop. £40 above B.S.
15% phos. cop. £50 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. Clifford & Son, Limited.

NICKEL SILVER, &c.

	per lb.
Ingots for raising	9d. to 1/3
Rolled—	
To 9 in. wide	1/3 to 1/9
To 12 in. wide	1/3½ to 1/9½
To 15 in. wide	1/3½ to 1/9½
To 18 in. wide	1/4 to 1/10
To 21 in. wide	1/4½ to 1/10½
To 25 in. wide	1/5 to 1/11
Ingots for spoons and forks	9d. to 1/5½
Ingots rolled to spoon size	1/– to 1/8½
Wire round—	
3/0 to 10 G.	1/6½ to 2/1½

with extras according to gauge.

AMERICAN IRON AND STEEL.

At Pittsburgh unless otherwise stated.

	Dols.
No. 2 foundry, Phila.	19.76
No. 2 foundry, Valley	18.50
No. 2 foundry, Birm.	14.00
Basic	20.26
Bessemer	20.76
Malleable	20.76
Grey forge	19.76
Ferro-mang. 80%	94.00
O.-h. rails, h'y, at mill	43.00
Billets	33.00
Sheet bars	33.00
Wire rods	36.00
	Cents.
Iron bars, Phila.	2.12
Steel bars	1.75
Tank plates	1.75
Beams, etc.	1.75
Skelp, grooved steel	1.80
Skelp, sheared steel	1.80
Steel hoops	2.20
Sheets, black, No. 24	2.55
Sheets, galv., No. 24	3.20
Sheets, blue an'l'd, No. 13	2.15
Wire nails	2.15
Plain wire	2.30
Barbed wire, galv.	2.80
Tinplates, 100-lb. box	$5.25

COKE (at ovens).

Welsh foundry	27/6
„ furnace	17/6 to 22/6
Durham and Northumberland—	
„ foundry	15/– to 15/6
„ furnace	14/6
Midlands, foundry	—
„ furnace	—

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. cokes	20×14 box		18/4½
„	28×20 „		36/9
„	20×10 „		26/4½
„	18½×14 „		19/1½
C.W.	20×14 „		16/6
„	28×20 „		33/9
„	20×10 „		23/6
„	18½×14 „		17/–
Terneplates	28×20		32/6 per box basis f.o.b.

SWEDISH CHARCOAL IRON & STEEL.

Pig-iron	£6	0	0	to	£7	10	0
Bars, hammered, basis	£17	10	0	to	£18	10	0
Bars and nail-rods, rolled, basis	£15	17	6	to	£16	15	0
Blooms	£10	0	0	to	£12	0	0
Keg steel	£32	0	0	to	£33	0	0
Faggot steel	£20	0	0	to	£24	0	0
Bars and rods dead soft, steel	£11	0	0	to	£14	0	0

All per English ton, f.o.b. Gothenburg.

TUBES AND FITTINGS.

Over ½ in. up to 6 in.

	Tubes.	*Fittings.*
Gas	62½%	47½%
Water ..	58½%	42½%
Steam ..	55%	37½%

W.I. 12½% extra.

DAILY FLUCTUATIONS.

Standard Copper (cash).

		£	s.	d.		
May	22 ..	54	7	6	dec.	12/6
,,	23 ..	54	0	0	,,	7/6
,,	26 ..	54	5	0	inc.	5/–
,,	27 ..	53	17	6	dec.	7/6
,,	28 ..	53	15	0	,,	2/6

Electrolytic Copper.

		£	s.	d.	
May	22 ..	60	10	0	No change
,,	23 ..	60	10	0	,, ,,
,,	26 ..	60	10	0	,, ,,
,,	27 ..	60	10	0	,, ,,
,,	28 ..	60	10	0	,, ,,

Standard Tin (cash).

		£	s.	d.		
May	22 ..	142	10	0	dec.	25/–
,,	23 ..	141	0	0	,,	30/–
,,	26 ..	141	17	6	inc.	17/6
,,	27 ..	143	5	0	,,	27/6
,,	28 ..	141	2	6	dec.	42/6

Tin (English ingots).

		£	s.	d.		
May	22 ..	143	10	0	dec.	25/–
,,	23 ..	142	0	0	,,	30/–
,,	26 ..	143	0	0	inc.	20/–
,,	27 ..	144	5	0	,,	25/–
,,	28 ..	142	0	0	dec.	45/–

Zinc Sheets (English).

		£	s.	d.		
May	22 ..	27	0	0	No	change
,,	23 ..	27	0	0	,,	,,
,,	26 ..	27	0	0	,,	,,
,,	27 ..	27	0	0	,,	,,
,,	28 ..	27	0	0	,,	,,

Spelter (ordinary).

		£	s.	d.		
May	22 ..	16	17	6	inc.	2/6
,,	23 ..	16	17	6	No	change
,,	26 ..	16	15	0	dec.	2/6
,,	27 ..	16	18	9	inc.	3/9
,,	28 ..	16	16	3	dec.	2/6

Lead (English).

		£	s.	d.		
May	22 ..	19	5	0	dec.	2/6
,,	23 ..	19	10	0	inc.	5/–
,,	26 ..	19	10	0	No	change
,,	27 ..	19	10	0	,,	,,
,,	28 ..	19	10	0	,,	,,

AVERAGE MONTHLY PRICES OF STEEL RAILS.

Year.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1908	6 2 6	6 0 0	6 0 0	5 15 6	5 15 0	5 15 0	5 15 0	5 15 0	5 15 0	5 15 0	5 15 0	5 10 0	5 16 3
1909	5 5 0	5 5 0	5 5 0	5 0 0	5 5 0	5 5 0	5 5 0	5 5 0	5 5 0	5 5 0	5 5 0	5 5 0	5 5 0
1910	5 5 0	5 7 6	5 7 6	5 7 6	5 10 0	5 10 0	5 10 0	5 10 0	5 10 0	5 10 0	5 10 0	5 10 0	5 8 11½
1911	5 15 0	5 15 0	5 15 0	5 12 6	5 12 6	5 12 6	5 12 6	5 12 6	5 12 6	5 12 6	5 12 6	5 12 6	5 13 1½
1912	5 13 1	5 15 0	5 15 0	5 15 7	6 1 6	6 6 3	6 7 6	6 8 0	6 11 3	6 12 6	6 12 6	6 13 9	6 4 4
1913	6 15 0	6 14 4½	6 12 6	6 12 6	6 12 6	6 12 6	6 12 6	6 12 6	6 10 0	6 10 0	6 10 0	6 10 0	6 12 0
1914	6 10 0	6 10 0	6 6 3	6 0 0	6 0 0	6 0 0	5 14 0	6 2 6	6 13 9	6 12 0	6 7 6	6 7 6	6 5 3½
1915	6 10 6	6 17 6	7 5 0	7 12 6	7 12 6	7 17 6	8 17 6	9 2 6	9 2 6	9 2 6	9 7 6	10 10 6	8 6 6½
1916	10 19 4	11 0 0	11 0 0	10 18 9	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6	10 9 10
1917	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6
1918	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6
1919	10 17 6	13 7 6	13 7 6	13 7 6	15 0 0	15 10 0	16 0 0	16 10 0	16 10 0	16 10 0	16 10 0	17 5 0	14 12 11
1920	18 15 0	19 5 0	20 7 6	22 0 0	23 0 0	23 0 0	24 0 0	25 0 0	25 0 0	25 0 0	25 0 0	25 0 0	22 18 11½
1921	23 5 0	20 4 0	18 0 0	17 0 0	15 0 0	15 0 0	14 0 0	14 0 0	14 0 0	11 12 6	10 10 0	10 0 0	15 4 3
1922	9 10 0	9 10 0	9 10 0	9 10 0	9 10 0	9 10 0	9 10 0	9 0 0	8 15 0	8 15 0	8 15 0	8 15 0	9 4 2
1923	8 17 6	9 2 0	10 5 0	10 10 0	10 10 0	10 10 0	9 15 0	9 0 0	8 15 0	8 15 0	8 19 0	9 5 0	9 9 10
1924	9 5 0	9 5 0	9 5 0	9 5 0	9 5 0	9 5 0	9 2 6	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	9 2 3½
1925	9 0 0	9 0 0	9 0 0	9 0 0	8 15 0	8 10 7½	8 10 0	8 10 0	8 10 0	8 4 0	8 0 0	8 0 0	8 11 7½
1926	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 7 6	8 10 0	8 10 0	8 10 0	8 10 0	8 3 11½
1927	8 10 0	8 10 0	8 10 0	8 2 6	8 2 6	8 2 6	8 2 6	8 2 6	8 2 6	8 3 0	8 5 0	8 5 0	8 4 10
1928	8 5 0	8 5 0	8 5 0	8 5 9	8 6 3	8 6 3	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 7 9½
1929	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0
1930	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	—	—	—	—	—	—	—	—

AVERAGE MONTHLY PRICES OF EAST COAST HEMATITE AT MIDDLESBROUGH.

Year.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Average.
	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
1915	83 11	88 6	94 8	107 0	102 6	101 3	98 9	98 7½	96 6	104 0	124 1	130 0	106 11½
1916	133 9	140 0	136 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6	128 1½
1917	122 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6
1918	122 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6
1919	122 6	122 6	122 6	122 6	179 2	190 0	197 6	200 0	200 0	200 0	200 0	200 0	171 4
1920	220 0	220 0	240 0	260 0	260 0	260 0	260 0	260 0	260 0	260 0	260 0	260 0	251 8
1921	240 0	220 0	180 0	180 0	180 0	160 0	160 0	160 0	137 0	127 6	117 6	104 6	162 2
1922	97 6	91 7½	100 0	98 6	97 1½	94 7	93 6	90 9	89 7	91 10½	93 0	93 2	94 5½
1923	94 6	104 9	122 0	126 10½	122 0	115 3	107 0	98 8½	98 10½	99 1½	100 6½	102 3	107 10½
1924	102 4½	101 3	99 7½	99 0	98 9½	97 4½	95 3½	93 1½	90 7½	88 0	88 4½	88 5	95 2½
1925	87 5	85 9	84 7½	82 6	80 10½	79 3	77 1½	75 7½	75 0	74 3½	74 9	76 0	79 5½
1926	77 3	77 9	77 3½	76 3	77 4½	78 0	79 8½	81 9	83 4½	87 7½	92 6	90 5½	81 7½
1927	90 0	90 0	86 3½	83 1½	80 6	78 0	76 6	75 4½	75 0	72 9	71 9	71 1½	79 2½
1928	69 7½	69 7½	69 9	70 0	70 0	69 3	68 7½	69 2	70 0	70 0	70 3	71 0	69 9½
1929	71 6	72 0	73 6	74 0	74 0	74 1½	74 9	75 6	76 1½	76 8½	78 1½	79 0	74 11½
1930	78 2½	78 0	76 9	75 0	74 0	—	—	—	—	—	—	—	—

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